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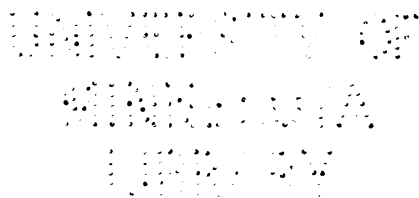
GUY'S HOSPITAL REPORTS

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EDITORIAL NOTICES

1. Papers for publication and editorial communications should be addressed to Dr. A. F. Hurst, Guy's Hospital, London, S.E.1.

2. Business communications regarding subscriptions, change of address, advertising, etc., should be addressed to the Managers, Oxford Medical Publications, 17, Warwick Square, Newgate Street, London, E.C.4.

3. The following papers are amongst those which will appear in forthcoming issues of the Reports :

J. Fawcett : Addison and Addison's Anæmia.

W. Hale White : Bright's Contributions to Medicine apart from Kidney Disease.

G. H. Hunt and M. S. Pembrey : Test of Physical Efficiency.

A. D. Fripp : Internal Derangements of the Knee-Joint.

A. F. Hurst and R. S. Rowland : Hour-Glass Stomach.

J. A. Ryle and T. I. Bennett : Further Studies in Gastric Secretion.

H. W. Barber : Pathogenesis of Lupus Erythenatosus.

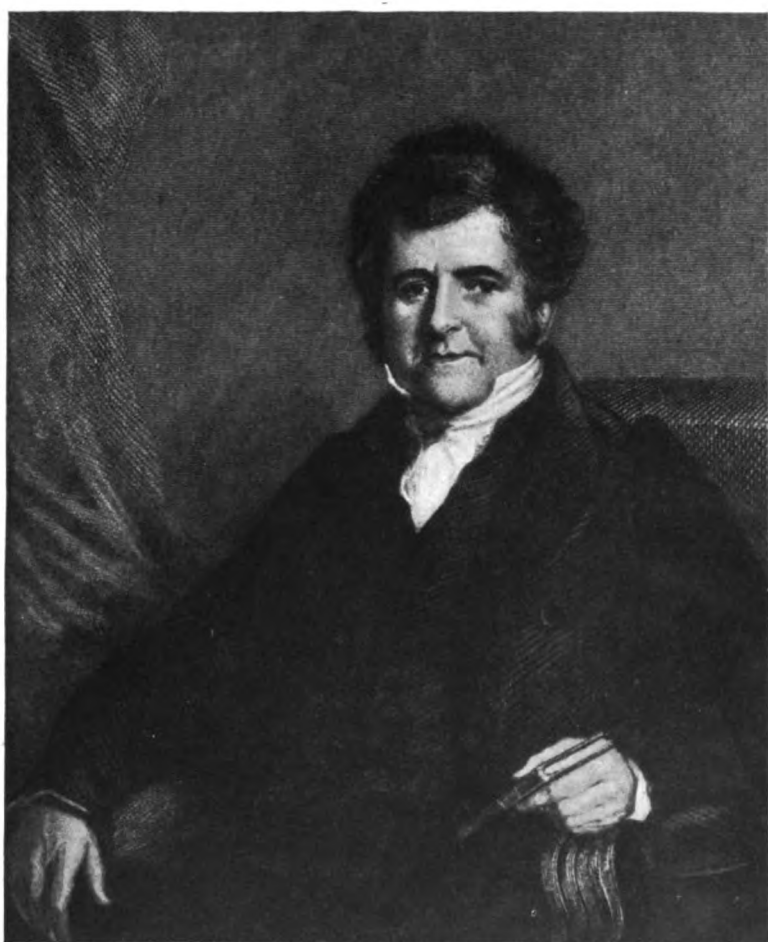
L. S. Debenham, J. Joffre and M. S. Pembrey : Observations on Secretion of Urine in a case of Ectopic Vesicæ.

Discussion on Rheumatoid Arthritis by various authors.

4. Readers are invited to send for publication short communications or criticisms on papers appearing in the Reports. These will be submitted to the writer of the original paper, so that he may reply in the same issue of the Reports.

5. Authors are allowed fifty reprints of their papers gratuitously. Additional copies may be had at cost price.

6. Owing to the extreme indefiniteness of what can be regarded as the termination of the War, and the consequent difficulty of deciding just when the records of the doings of Guy's men in the War can be regarded as final and complete, the issue of the last volume of the old series of Guy's Hospital Reports in the form of a War Memorial Volume has been unavoidably delayed ; and although much of it is in print the issue of the volume itself is not anticipated before Easter of 1921.



Rich^d Bright

PHYSICIAN TO GUY'S HOSPITAL. 1820 TO 1843

RICHARD BRIGHT

AND

HIS DISCOVERY OF THE DISEASE BEARING HIS NAME

By SIR WILLIAM HALE-WHITE, K.B.E., M.D., Consulting Physician
to Guy's Hospital.

RICHARD BRIGHT was born at Queen Square, Bristol, on September 28, 1789. He was the third son of Richard Bright, who lived at Ham Green, Somerset, and was a member of the banking firm Ames, Bright and Cove. Young Bright went to school at Bristol and Exeter, and in 1808 began to study medicine at Edinburgh. In 1810 he accompanied Sir George Mackenzie to Iceland and wrote the botanical and zoological parts of Mackenzie's *Travels in Iceland*. The book is beautifully illustrated, and some of the smaller drawings are by Bright. Mackenzie speaks of his pleasing manners, his cheerful and ready exertion, and his undeviating good humour. On his return he lived for two years in the house of one of the resident officers in Guy's Hospital, where he continued his medical studies, reading a paper before the Medico-Chirurgical Society on cases of erysipelas he had seen at Guy's between May and July, 1811. In the same year he also read a paper before the Geological Society on the strata in the neighbourhood of Bristol. In 1812 he returned to study at Edinburgh and graduated M.D. on September 13 with a thesis on erysipelas. From Edinburgh he went to Cambridge and was two terms at Peterhouse, but left there to come to London, where he became a pupil at the Public Dispensary under Dr. Bateman. In 1814 he started on a tour through Holland, Belgium, Berlin, Vienna, Austria and Hungary, and on his return in 1815 he arrived at Waterloo a fortnight after the battle. He observed and studied everything he came across, medical or otherwise, and in 1818 published *Travels from Vienna through Lower Hungary, with some remarks on the state of Vienna during the Congress in the year 1814*. The book is a well-printed quarto of over seven hundred pages, entertaining as an account of travel and full of detailed information which ought to be of value to students. It exemplifies Bright's wonderful power of observation and description, his wide reading, his accuracy, as is shown by the tables, maps and

appendices, and his artistic ability, for it is illustrated by beautiful engravings from sketches by himself. Medical allusions are few, but the leading doctors of Vienna are described, especially De Carro, a pupil of Jenner's, who had his own children vaccinated and was the means of introducing vaccination extensively. Most of the patients in the Viennese hospitals paid; there was a lying-in hospital into which women were admitted secretly, and they left without any revelation of their identity.

On December 23, 1816, Bright was admitted a licentiate of the Royal College of Physicians, and shortly afterwards he was elected Assistant Physician to the London Fever Hospital, where he caught a severe attack of fever, from which he nearly died. In 1818 he travelled for nearly a year through Germany, Italy and France. In 1820 he returned to London, took a house in Bloomsbury Square, and was in this year elected Assistant Physician to Guy's Hospital, resigning his position at the Fever Hospital. In 1821 he was elected an F.R.S., in 1824 full Physician to Guy's, and in 1832, although only a licentiate, he was, with applause, elected a Fellow of the College of Physicians. In 1837 he was President of the Royal Medico-Chirurgical Society. He resigned his post of Physician to Guy's in 1843. By 1831 he had removed to 11 Savile Row, where he died of aortic disease on December 16, 1858. The very good life of him in the *Dictionary of National Biography* is by Dr. J. F. Payne. Sir Samuel Wilks gives an excellent account in the *Biographical History of Guy's Hospital*, and obituary notices are to be found in the *Lancet* and *Medical Times and Gazette* at the time of his death. There is a tablet on the south wall of St. James, Piccadilly, with this inscription: "Sacred to the memory of Richard Bright, M.D., D.C.L., Physician Extraordinary to the Queen, Fellow of the Royal Society and other learned Bodies. He departed this life on 16 December, 1858, in the sixty-ninth year of his age. He contributed to medical science many discoveries and works of great value and died while in the full practice of his profession, after a life of warm affection, unsullied purity and great usefulness."

Richard Bright was an extraordinary man. It is impossible to place geniuses in order, but he would certainly be among the first five or six in our profession. To him and to a few others an altogether marvellous power of observation has been given, but Bright's genius took him further than mere observation, however brilliant, for he could correlate his observations.

Dropsy must have been recognised ever since it appeared in the human race, and long before Bright's time it was known that the urine sometimes coagulated on boiling; even atrophied

kidneys had been noticed. But, as will presently appear, Bright by his observations was able to say disease of the kidney is the cause of albuminuria, dropsy and many other symptoms, and of post-mortem appearances which he enumerates.

This was such an important discovery that it has overshadowed others that he made, but he carried out clinical observations and post-mortem examinations in almost every disease, and indeed paid most attention to diseases of the nervous system. He records a case in which there were right-sided fits, and says "my reason for supposing the epileptic attacks depended upon a local affection . . . was the degree of consciousness which was observed to be retained during the fits." He expected to find a lesion on the left side of the brain, and the post-mortem examination showed he was correct. Thus he was a pioneer in the subject of cerebral localisation. He was one of the first who described acute yellow atrophy of the liver, pigmentation of the brain in miasmatic melanæmia, condensation of the lung in whooping-cough, and the mitral murmur in chorea.

He was not narrow, for we have seen that he was a traveller, a geologist, an artist, a writer and a linguist. He was an indefatigable worker, and for many years spent six hours daily at the Hospital. He was a cheerful, attractive, honourable man, admired by his profession, who frequently sought his help in consultation, beloved in this country and better known throughout the civilised world than any British physician since Harvey. The affectionate relations between him and the students is seen in the fact that they asked him to reprint an address to them which he gave in 1832. We shall see how his colleagues at Guy's liked to help him. He inspired the younger men to aid him in his researches, but was always most careful to acknowledge the assistance given. He was ungrudging in his admiration for the work of others and was intensely proud of Guy's Hospital and its Museum.

The Lancet of December 25, 1858, said : "The sudden and unexpected demise of Dr. Bright has created a deep impression of grief and regret such as only a sense of irretrievable loss could occasion. In him all felt that the medical profession of England had lost one of the most original, observant and philosophic minds. A man of peculiar independence of thought, of high *morale* and untiring energy, he contributed more perhaps than any other to form the medical opinion of his day. . . . By the singular devotion to pathological investigation which characterised his career, he was at once enabled to accomplish investigations which have immortalised his name."

This very brief account of this great man is only to introduce to the reader the object of this paper, namely, to give in Bright's own words an account of his famous discovery of the disease named after him.

In the year 1827 there appeared the first of the renowned two volumes by Richard Bright, entitled *Reports of Medical Cases selected with a view of illustrating the symptoms and cure of diseases by a reference to Morbid Anatomy*. The book is dedicated to Benjamin Harrison, the Treasurer, and to William Babington, who, having retired from the active staff of Guy's Hospital, was now one of the Governors. It, like all Bright's work, is essentially Guy's work, for almost all his observations were made in the Hospital. In the preface he says: "It is my wish in thus recording a number of cases, to render the labours of a large Hospital more permanently useful, by bringing together such facts as seem to throw light upon each other. . . . To connect accurate and faithful observation after death with symptoms displayed during life, must be in some degree to forward the objects of our noble art. . . . Amongst the observations contained in this volume, there are some of which I must bear the responsibility alone. Such are the statements and conjectures regarding the dependence of a peculiar class of Dropsies on disease and irritation of the kidneys; such are some observations on peculiar changes in the structure of the liver, in the investigation of which, however, as in many other cases, I have been kindly assisted by my friend Dr. Bostock. . . . And such are the hints thrown out on the influence of the peculiar state of the mesenteric absorbents on the symptoms of Phthisis. There are other subjects, on the contrary, where I write with greater confidence, because borne out by the testimony of my contemporaries. . . . The work which I now commence will not, in theory at least, be thoroughly completed, until every disease which influences the natural structure, or originates in its derangements, has been connected with the corresponding organic lesion. . . . I have the satisfaction of feeling that each volume, whether it finally form a part of an extensive work on *Morbid Anatomy* or not, will in the meantime be complete within itself as a volume of Hospital Reports.

"It is a pleasing, and yet no easy task, to acknowledge the kindness of those many friends who in various ways have assisted me in this undertaking. I may truly say that I have met with the most cheerful compliance in all my wishes from everyone connected with our establishment.

"14, *Bloomsbury Square*,

"August 10th, 1827."

The subjects treated of in Volume I are diseases of the kidney in association with anasarca and albuminuria, diseases of the liver with anasarca and ascites, diseases of the thorax followed by dropsy, diseases of the lungs, and diseases of the intestines in fever. Volume II was published three years later and consists of two parts, each larger than Volume I. The two volumes contain sixty-five hand-coloured plates, which are as beautifully executed as possible; the colours to-day are still perfect. The second volume is entirely occupied with diseases of the nervous system. In the preface to it Bright says, "My opportunities have increased . . . by the great augmentation in the sumptuous Hospital to which I am attached, and in which I am proud to say that my colleagues, whether medical or surgical, have by their unremitting kindness shown how little jealousy interferes between the two professions."

Here we are only concerned with Bright's work on diseases of the kidney and albuminuria, and, as far as possible, I will give it in his own words. The most celebrated part of his *Reports* is the first 126 pages of Volume I. This section is entitled, "Cases illustrative of some of the appearances observable on the examination of Diseases terminating in Dropsical effusion." He begins by reminding the reader that one great cause of dropsical effusion appears to be obstruction to the venous circulation. But, says Bright, "There are other appearances to which I think too little attention has hitherto been paid. They are those evidences of organic disease which occasionally present themselves in the structure of the *kidney*, and which, whether they are to be considered as the cause of the dropsical effusion or as the consequence of some other disease, cannot be unimportant. Where those conditions of the kidney to which I allude have occurred, I have often found the dropsy connected with the secretion of albuminous urine, more or less coagulable on the application of heat. . . . I have never yet examined the body of a patient dying with dropsy attended with coagulable urine, in whom some obvious derangement was not discovered in the kidneys."

The appearance of the coagulated albumen is not always quite the same: "most commonly when the urine has been exposed to the heat of a candle in a spoon, before it rises quite to the boiling point it becomes clouded, sometimes simply opalescent, at other times almost milky, beginning at the edges of the spoon and quickly meeting in the middle. During some part of the progress of these cases of anasarca, I have in almost all instances found a great tendency to throw off the red particles of the blood by the kidneys, betrayed by various degrees of

6 BRIGHT AND BRIGHT'S DISEASE

hæmaturia, from the simple dingy colour of the urine, which is easily recognised, or the slight brown deposit—to the completely bloody urine. . . . In all cases in which I have observed the albuminous urine, it has appeared to me that the kidney has itself acted a more important part, and has been more deranged both functionally and organically than has generally been imagined. In the latter class of cases I have always found the kidney decidedly disorganised. In the former, when very recent, I have found the kidneys gorged with blood. . . . It is

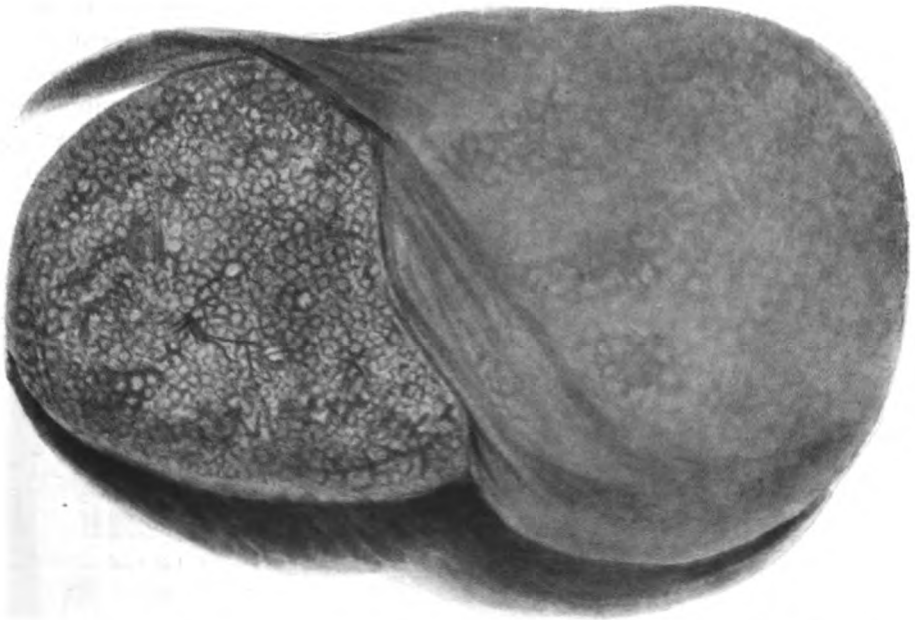


The Clinical Wards in which Bright carried out his observations were two, each in Clinical Building; they were exactly alike. John Ward was for male patients. The accompanying photograph shows the interior of Miriam, the ward for female patients.

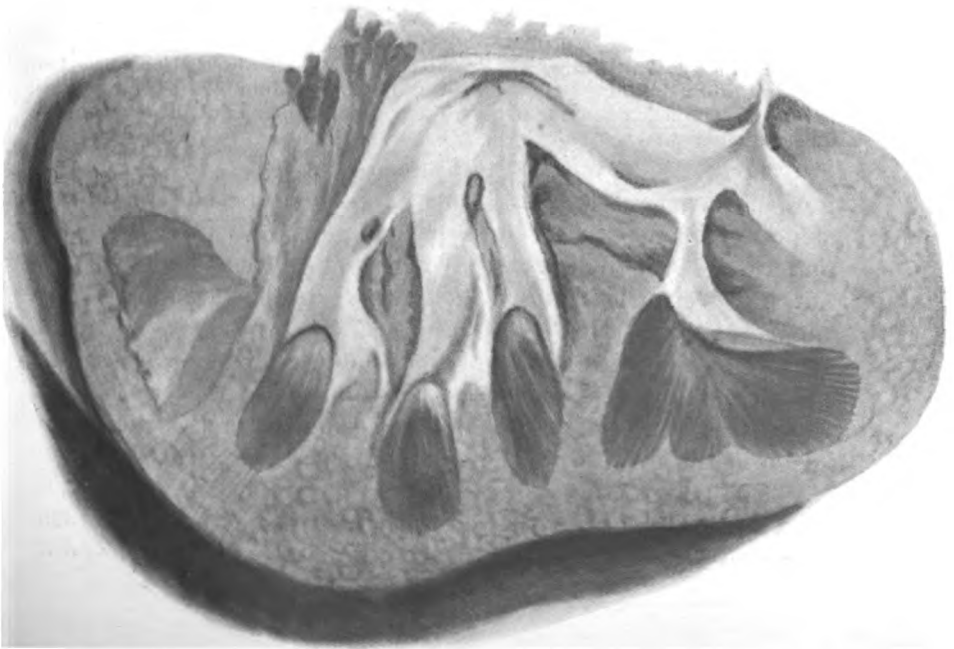
now nearly twelve years since I first observed the altered structure of the kidney in a patient who had died dropsical; and I have still the slight drawing which I then made. It was not, however, till within the last two years that I had an opportunity of connecting these appearances with any particular symptoms, and since that time I have added several observations. I shall now detail a few cases, beginning with the two first, in which I had an opportunity of connecting the fact of the coagulation of the urine with the disorganised state of the kidneys."

Then follow the clinical notes of twenty-three cases to illustrate this point. All were patients during the years 1825, 1826 and 1827, and almost all were inmates of Guy's Hospital,

"KIDNEY IN DROPSY."



"FIG. 1. External view of one of the kidneys of KING, from half of which the tunic is removed, showing an advanced stage of that granulated condition of the organ which was in this case connected with the secretion of albuminous urine. Anasarca and hydrothorax accompanied the disease."



"FIG. 2. A longitudinal section of the same kidney, showing the most advanced stage of granular charge."

—

and most of them came from the Clinical Ward. Considerably over a half were fatal; a post-mortem examination was made on all that died. The account of this examination is very full, the kidneys are described, there is a series of beautifully coloured plates to show the appearance of the kidneys, and there is a short commentary on each case. It is impossible here to reproduce the cases in detail, but we may mention the first of a series which has influenced the course of medicine profoundly. John King, aged thirty-four, an intemperate sailor, was admitted into Clinical Ward, Guy's Hospital on October 12, 1825 under the care of Dr. Bright, suffering from general œdema, scanty urine and pain in the loins. He had hæmaturia, but this passed away, and the urine, when clear, coagulated when heated; the pulse was hard. The *sectio cadaveris* revealed acute pericarditis, œdema of the lungs, pleural effusion, a large heart and ascites. "The kidneys were completely granulated throughout; externally the surface rough and uneven; internally all traces of natural organisation nearly gone, except in the tubal parts." There is a coloured picture (here reproduced) of them in Plate I. In the commentary Bright says, "This is a well-marked example of a granulated condition of the kidneys, connected with the secretion of coagulable urine." He inclines to the opinion that the "disease of the kidney was the first established." He considers that neither the disease of the lungs, pleura nor heart was the primary condition, nor was there any disease of the liver to explain the ascites. He points out that pain in the loins is frequently a symptom of renal disease, and that "the tendency to inflammatory affection in this man was a striking feature in his case, and appears to me connected immediately with the condition of the kidneys."

The plate illustrating the state of the kidneys shows a chronic granular kidney with a diminution of the cortex, or, as we should say, interstitial nephritis, and it is also clear that there is abundant tubal change. Therefore John King becomes a classic case, presenting all the essential symptoms of chronic renal disease and the first recorded case in which they were successfully correlated with the condition found after death.

Bright's next allusion to renal disease is in the second of his Gulstonian lectures,* which were delivered in 1833. Then, as now, "team work" was carried out at Guy's, for he says: "I have lately had great assistance from the intelligent and zealous co-operation of three of my young friends and pupils, Mr. Barlow, Mr. Tweedie and Mr. Rees." They examined the urines of two hundred and ninety-six patients; many samples

* *London Medical Gazette*, Vol. XII, p. 378.

gave no precipitate either with heat or nitric acid, many gave a precipitate with only one, but twenty-six gave a precipitate with both. Bright points out that phosphates and urates must be distinguished from albumen; all these three may be present in health, but he clearly appreciates the importance of albuminuria, for he says: "In the natural and healthy condition of the urine little or no albumen is to be detected." The specific gravity of the urine is very variable. In many cases of albuminous urine there is an excess of urea in the blood. He describes the varieties of nephritis found in the post-mortem room, and says that both anasarca and albuminuria may be absent in renal disease. He alludes to the enlargement of the heart, the serous effusions, the headache, the coma, and cerebral hæmorrhage found in association with disease of the kidneys, and he reaches this conclusion: "My conviction is complete as to the existence of some decided connection between the three facts—anasarca, coagulable urine and diseased function going on to diseased structure of the kidney."

His final and most extensive communication on the subject of nephritis appeared in the first volume of the *Guy's Hospital Reports*, published in 1836. It consists of two papers. The first is entitled "Cases and Observations Illustrative of Renal Disease accompanied with the Secretion of Albuminous Urine." The second follows it immediately and is called "Tabular View of the Morbid Appearances Occurring in One Hundred Cases in Connection with Albuminous Urine."

I will now reprint these papers, but as they occupy sixty-five pages of the *Reports*, they will be condensed. The original words will, however, be given.

The first paper runs thus:—

"The importance and extensive prevalence of that form of disease, which, after it has continued for some time, is attended by the peculiar changes in the structure of the kidney, now pretty generally known by the names of 'mottling,' 'white degeneration,' 'contraction,' or 'granulation,' impresses itself every year more and more deeply on my mind; and whether I turn to the wards of the hospital, or reflect on the experience of private practice, I find, on every side, such examples of its fatal progress and unrelenting ravages, as induce me to consider it amongst the most frequent, as well as the most certain causes of death in some classes of the community, while it is of common occurrence in all; and I believe I speak within bounds, when I state, that not less than five hundred die of it annually in London alone. It is, indeed, an humiliating confession, that, although much attention has been directed to this disease

for nearly ten years, and during that time there has probably been no period in which at least twenty cases might not have been pointed out in each of the large hospitals of the metropolis—and there is reason to believe that double that number may, at this moment, and at all times, be found in the wards of Guy's Hospital—yet little or nothing has been done towards devising a method of permanent relief, when the disease has been confirmed; and no fixed plan has been laid down, as affording a tolerable certainty of cure in the more recent cases. I believe that our want of success, in what are considered the more recent attacks, is frequently owing to the fact, that the disease is far more advanced than we suspect, when it first becomes the object of our attention; and I am most anxious, in the present communication, to impress upon the members of our profession the insidious nature of this malady, that they may be led to watch its first approaches, with all the solicitude which they would feel on discovering the first suspicious symptoms of phthisis or of epilepsy. There is great reason to suppose that the seeds of this disease are often sown at an early period; and that intervals of apparent health produce a false security in the patient, his friends, and his medical attendants, even where apprehension has been early excited.

“The first indications of the tendency to this disease is often hæmaturia, of a more or less decided character; this may originate from various causes, and yet may give evidence of the same tendency: scarlatina has apparently laid the foundation for the future mischief. . . . Intemperance seems its most usual source; and exposure to cold the most common cause of its development and aggravation. . . .

“The history of this disease, and its symptoms, is nearly as follows:—

“A child, or an adult, is affected with scarlatina, or some other acute disease; or has indulged in the intemperate use of ardent spirits for a series of months or years: he is exposed to some casual cause or habitual source of suppressed perspiration: he finds the secretion of his urine greatly increased, or he discovers that it is tinged with blood; or, without having made any such observations, he awakes in the morning with his face swollen, or his ankles puffy, or his hands œdematous. If he happen, in this condition, to fall under the care of a practitioner who suspects the nature of his disease, it is found, that already his urine contains a notable quantity of albumen: his pulse is full and hard, his skin dry, he has often headache, and sometimes a sense of weight or pain across the loins. Under treatment more or less active, or sometimes without any

treatment, the more obvious and distressing of these symptoms disappear; the swelling, whether casual or constant, is no longer observed; the urine ceases to evince any admixture of red particles; and, according to the degree of importance which has been attached to these symptoms, they are gradually lost sight of, or are absolutely forgotten. Nevertheless, from time to time the countenance becomes bloated; the skin is dry; headaches occur with unusual frequency; or the calls to micturition disturb the night's repose. After a time, the healthy colour of the countenance fades; a sense of weakness or pain in the loins increases; headaches, often accompanied by vomiting, add greatly to the general want of comfort; and a sense of lassitude, of weariness, and of depression, gradually steal over the bodily and mental frame. Again, the assistance of medicine is sought. If the nature of the disease is suspected, the urine is carefully tested; and found, in almost every trial, to contain albumen, while the quantity of urea is gradually diminishing. If, in the attempt to give relief to the oppression of the system, blood is drawn, it is often buffed, or the serum is milky and opaque; and nice analysis will frequently detect a great deficiency of albumen, and sometimes manifest indications of the presence of urea. If the disease is not suspected, the liver, the stomach, or the brain divide the care of the practitioner, sometimes drawing him away entirely from the more important seat of disease. The swelling increases and decreases; the mind grows cheerful, or is sad; the secretions of the kidney or the skin are augmented or diminished, sometimes in alternate ratio, sometimes without apparent relation. Again, the patient is restored to tolerable health; again he enters on his active duties: or he is, perhaps, less fortunate;—the swelling increases, the urine becomes scanty, the powers of life seem to yield, the lungs become œdematous, and, in a state of asphyxia or coma, he sinks into the grave; or a sudden effusion of serum into the glottis closes the passages of the air, and brings on a more sudden dissolution. Should he, however, have resumed the avocations of life, he is usually subject to constant recurrence of his symptoms; or again, almost dismissing the recollection of his ailment, he is suddenly seized with an acute attack of pericarditis, or with a still more acute attack of peritonitis, which, without any renewed warning, deprives him, in eight and forty hours, of his life. Should he escape this danger likewise, other perils await him; his headaches have been observed to become more frequent; his stomach more deranged; his vision indistinct; his hearing depraved; he is suddenly seized with a convulsive fit, and becomes blind.

He struggles through the attack; but again and again it returns; and before a day or a week has elapsed, worn out by convulsions, or overwhelmed by coma, the painful history of his disease is closed.

“Of the appearance presented after death, enough will be said in another part of the present communication: but one question may be asked in this place—Do we always find such lesion of the kidney as to bear us out in the belief, that the peculiar condition of the urine, to which I have already referred, shews that the disease, call it what we may, is connected necessarily and essentially with the derangement of that organ? After ten years’ attentive—though, perhaps, I must not say completely impartial observation—I am ready to answer this question in the affirmative; and yet I confess that I have occasionally met with anomalies which have been somewhat difficult to explain. . . .”

“There has not yet, perhaps, been sufficient time, since this disease of the kidneys first attracted attention, to say to what extent life may be prolonged while the body is under its influence; but I believe with care, its fatal effects may be kept at bay, and a hazardous life may be protracted for many years. Should that care be neglected, the chance of life will be greatly diminished.

“The cases which I now offer will be found to bear upon many points in the history I have just sketched out; and amongst others, will tend to illustrate the subject of the probable duration of the disease, and some of the more insidious attacks which attend the fatal termination.”

Here Bright introduces the clinical and post-mortem accounts of ten cases of albuminous urine with nephritis. If we except the retinitis (there were no ophthalmoscopes in those days) and the measure of the blood pressure, every ordinary clinical symptom is mentioned; deaths from uræmia, cerebral hæmorrhage, and acute inflammation of serous membranes are all recorded. To illustrate the marvellous completeness of Bright’s powers of observation it may be mentioned that he knew that sometimes vision was impaired and that sometimes the pulse was hard.

To proceed in his own words—

“Nothing can be more striking than the similarity which is observable in all these cases. I am not aware of any disease in which the character is more completely preserved, or in which the symptoms more clearly mark a specific form of malady. In the first eight cases, the termination, as well as the progress of the disease, bore the most perfect resemblance; and the

peculiar train of cerebral symptoms, by which their advanced stages have been attended, have little analogy, when taken as a whole, with the symptoms of any other cerebral affection. The two last cases differ from the rest only in their mode of termination; and I have related them as the two most recent illustrations of a very frequent result of the disease.

“Of the insidious nature of this malady, and its fatal tendency, these cases afford a pretty convincing proof: and the fact that so many of these have come within my own observation in a limited time, would be tolerable evidence of the extreme frequency of the disease. Yet the cases I have now detailed, but more especially the many more which the length of the present communication obliges me to defer, are chiefly such as I have, without any intention of publication, chanced to enter in my note-book, and form but a small portion of those which I have seen: but, in order to obtain a more accurate idea of the actual prevalence of the disease, it is necessary to have recourse to another species of evidence: and accordingly, in the winter of 1828-9, I instituted a series of experiments, by taking the patients promiscuously, as they lay in the wards, and trying the effects of heat upon the urine of each, and at the same time employing occasionally other re-agents. The whole number I took amounted to a hundred and thirty; out of which no less than eighteen proved to have urine decidedly coagulable by heat: and in twelve more, traces of albumen were found: giving, therefore, an average of at least one in six, if not one in four of the whole number. In order to shew how the experiment was made, and the nature of the table I constructed, I will introduce six consecutive cases out of a male, and six out of a female ward; and it is worth remarking, that in every instance, where the result allowed us to ascertain the state of the kidneys, it corresponded with the diagnosis yielded by the table. Those who had albuminous urine were found to have more or less of this disease in the kidneys; whilst those whose urine did not coagulate by heat had kidneys without disease.”

The author then discusses the treatment. He doubts “whether we have it in our power, as yet, even at the earliest periods, to destroy the liability to relapse, or overcome the morbid tendency; but at all events, the management of the early stage of the disease is easy, when compared with the treatment in its more confirmed and protracted forms. . . . I cannot, from my own experience, entertain a hope that diaphoretics are capable of curing any large proportion of confirmed

cases. . . . Till this symptom (albuminuria) be removed the disease certainly exists : and even when it is removed, it is often absent but a short time, and it is, for many years, liable to return. It can never be sufficiently impressed on the minds of practitioners, that the anasarca . . . is but a symptom." But he says anasarca may be absent throughout or it may disappear and yet the disease be fatal. As diaphoretics he used antimonial powders, compound ipecacuanha powder and liquor ammoniæ acetatis, with the warmth of the bed, a warm bath, fomentations and large linseed poultices. He is particularly insistent on the necessity of keeping the skin warm ; hence he advises an inner dress of flannel and residence in a suitable climate. Bleeding may be useful in the earlier stages, but with regard to the later periods " when we call to mind the constant loss of albuminous matter which the system is sustaining by the kidneys, and the peculiar pallid hue which the patient assumes, we shall pause before we venture to afford temporary alleviation, at a still further expense of the more nutritious and stimulating portions of the blood."

Cupping the nape of the neck may relieve the headache, and a few leeches to the loins may assuage the pain there. He calls attention to the value of acupuncture for œdema, but " all attempts to draw off the serum by mechanical means should be most cautiously conducted ; for the powers of repair are weak and there is a great tendency to erythematous inflammation." He is opposed to the use of mercury. Elaterium used with care may be beneficial. " With regard to diuretics, I have generally wished to abstain from all except digitalis. . . . I look upon this class of remedies, however, in the light of a necessary evil in some cases ; and do not feel authorised in recommending their employment. . . . A great deal still further depends upon diet. Where milk is grateful, if it sits easily on the stomach, and is freely digested, I believe it to be one of the best aliments which can be taken. . . ." The great rule is to avoid everything which obviously deranges the stomach, and to take tonic and nutritive food. " The less of wine and spirituous liquors is taken, the better."

Every precaution must be taken to avoid chill to the surface or check perspiration. If exercise be taken, it must be gentle. This surely is a masterly exposition of the treatment of what was then a new disease, and now nearly a century later we cannot do any better.

Bright's second paper in the *Guy's Hospital Reports* begins with a tabular view of the morbid appearances occurring in one

hundred cases in connection with albuminous urine. The details are extraordinarily complete and testify to the care with which the examinations were made. "In almost all I have been present at the examination after death." His comments on the cases are as follow:—

"From the analysis of the foregoing tabular view, many curious facts respecting the derangement of different organs connected with granular kidneys are brought to light; for it is most probable, that a hundred cases of one disease, collected at different times, and with no particular object in view, will yield results which will, in the main, be borne out by the comparison of any other equal number of cases of the same disease. The first circumstance which strikes the mind, is the extent and frequency to which the derangement of one organ is connected with the derangement of several others: yet we are not at liberty to assume, that the disease of the kidney has been the primary cause on which the disease of the rest depended. It may be, that some other organ has first suffered, and that the kidneys, together with the rest, have become involved. I confess I am inclined to believe that the kidney is the chief promoter of the other derangements. The only organ, except the kidney, which I think, on taking a review of the history of this disease, might probably act as the primary cause, is the skin; and this is so closely connected in its derangements with the kidney, that the relations of their lesions, as regards cause and effect, become equivocal. It is, however, to be held in mind, that the secretion of the skin is quite as much interrupted, for a time, in many other states of disease, without the albumen making its appearance in the urine; in diabetes, for instance, in jaundice, and in certain stages of various inflammatory and febrile diseases. Moreover, it is not a fact, that in every case, or during the whole course of the disease under consideration, the skin is not perspirable: on the contrary, we often establish, for many months, the secretion of the skin, while the urine remains albuminous; as we occasionally succeed in doing in cases of diabetes, without essentially changing the character of the urine. In almost every case, the first impression which brings on the anasarca is suppression of perspiration; but it is almost as constantly the fact, that the kidneys have undergone some previous irritation, and very likely that the albuminous urine, in most cases, existed previously to the occurrence of those symptoms by which it has been recognised, more particularly previous to the anasarca.

"The changes effected in the blood by the long continuance of this disease are quite sufficient to account for its most extensive

derangement. The extraordinary manner in which the blood becomes impoverished and robbed every successive day of a portion of its most nutritive parts must, of itself, be considered a most efficient cause of predisposition to disease; and the fact, established now by a great accumulation of evidence, and supported by the names of Prout and Bostock, of Christison, Gregory, Babington, and others, that the chemical qualities of the blood are so far changed, that urea is to be detected in that fluid, or, at all events, certain constituents scarcely distinguishable from it, is still further to be viewed as a source of disease springing immediately out of the defective action of the kidney. On the other hand, it cannot be denied, that if the function of the skin is suddenly interrupted, derangements are likely to arise in various organs; and as, in many instances, the kidney most evidently receives a very injurious impression from the suppression of the perspiration; so other organs may be in turn affected through the same medium. I do not therefore by any means assert, that all the lesions which the foregoing table details, flow as a consequence from the kidney alone; but that they are such derangements as generally co-exist with this peculiar disease of that organ.

“The principal lesions display themselves in the circulating and respiratory systems, and in the serous membranes. The heart and the lungs, the pleura, the arachnoid and the peritoneum, have, in a large majority of cases, shewn marks of disease; while the liver, the spleen, the pancreas, and even the intestines, have frequently been, to all appearance, in a state of health, and have comparatively seldom given proof, by their structure, of any peculiarly diseased action. Of all the membranes, the pleura has decidedly been most often diseased; but that disease has, in forty cases, consisted of old adhesion; which, though it might have been connected with the first attack of renal disease, or might have taken place at some later period, in connection with that affection, may probably only mark the liability of the individual to be affected by atmospheric changes, and may have been the result of some casual inflammatory attack. At all events, the twenty-six cases in which the pleura was apparently healthy, and in three of which its freedom from disease is distinctly stated, prove, that however general a limited inflammatory action of the pleura may have been, it forms no essential part of the disease. That the pleura is, however, liable to inflammatory action, in a large proportion of these cases, may be inferred from the sixteen instances of recent inflammation; while the serous effusion, which has occurred in forty-one cases, has been connected with that general loss of

balance between the actions of the exhalents and the absorbents which is obvious in every part of the system.

"The same tendency to disease which is manifest in the pleura, shews itself, though in a less degree, in other serous membranes. In the pericardium, we have found six instances of old adhesion, twelve or thirteen of well-marked, recent, and often most acute inflammatory action; and twenty-three of the effusion of clear serum, in three of which a false membrane had been formed by chronic action: and again, looking to the arachnoid, we find that membrane rendered opaque, probably by a more or less severe inflammatory action, in thirteen cases; while well-marked serous accumulation had taken place beneath it in twenty-nine cases, and had partially distended the ventricles in six.

"The deviations from health in the heart are well worthy of observation; they have been so frequent, as to shew a most important and intimate connection with the disease of which we are treating; while at the same time there have been twenty-seven cases in which no disease could be detected; and six others, which, from not having been noted, lead to the belief that no important deviation from the normal state existed. The obvious structural changes in the heart have consisted chiefly of hypertrophy with or without valvular disease: and what is most striking, out of fifty-two cases of hypertrophy, no valvular disease whatsoever could be detected in thirty-four: but in eleven of these thirty-four, more or less disease existed in the coats of the aorta; still, however, leaving twenty-two without any probable organic cause for the marked hypertrophy generally affecting the left ventricle. This naturally leads us to look for some less local cause, for the unusual efforts to which the heart has been impelled: and the two most ready solutions appear to be, either that the altered quality of the blood affords irregular and unwonted stimulus to the organ immediately; or, that it so affects the minute and capillary circulation, as to render greater action necessary to force the blood through the distant sub-divisions of the vascular system. The valves chiefly affected have been the semilunar valves of the aorta and the mitral; and in three cases, the tricuspid has been somewhat deranged. In three cases, likewise, the disease of the valves has been unattended by any hypertrophy of the heart.

"It is observable, that the hypertrophy of the heart seems, in some degree, to have kept pace with the advance of disease in the kidneys; for in by far the majority of cases, where the muscular power of the heart was increased, the hardness and contraction of the kidney bespoke the probability of a long

continuance of the disease. Six cases are noted, in which the heart was soft and flaccid, and four in which it was unusually small; and in most of these, though not in all, the disease of the kidney had not proceeded to the state of contraction and hardness.

“The principal diseases of the lungs have been œdema and bronchitis, frequently attended by an emphysematous condition of certain portions. Œdema has occurred in thirty-one cases; and it is very commonly the immediate cause of dissolution, or of the increased distress towards the approaching termination of the chronic form of the disease. In six cases, recent, and in five old, traces of pneumonia were found; while the embarrassment to the circulation, caused by these various diseases of the heart and lungs, had occasionally given rise to the effusion of blood into the tissue of the lungs, in the form which is now known by the term of pulmonic apoplexy. The instances in which phthisis, or any form of scrofulous or tuberculous disease, has been connected with the renal affection, have been decidedly rare; so that in only four cases has recent phthisis developed itself: and what is somewhat remarkable, in more than double that number the disease seems to have made a certain inroad upon the upper lobes of the lungs, and then to have sunk into a state of quiescence, or entirely subsided; from which we should perhaps be inclined to infer, that so far from these diseases being associated, the condition of the body in this form of renal disease is unfavourable to the existence of phthisis, or that it is certainly not peculiarly apt to occur in tuberculous constitutions.

“With regard to the liver and the abdominal viscera generally, as compared with the heart and lungs, a very great immunity from structural disease is to be observed; a fact the more remarkable, as the habits of intemperance with which the renal disease is so frequently connected are those which might be expected to act very directly on the liver and digestive organs; indeed, to this day, the impression is so strong, as to the injurious effects of stimulants being manifested chiefly on the liver, that the majority of practitioners no sooner see the bloated countenance of anasarca connected with the history of intemperance, than they proceed to consider in what way the depraved action of the liver is to be corrected, and its morbid changes retarded. Looking to the tables before us, a very different conclusion forces itself upon our mind, as to the condition of the liver in general anasarca, and in that state of cachexia which often attends upon intemperate habits. We here find, in thirty-one cases, the liver distinctly stated to be

healthy; and in nine other cases, so free from all suspicion of deranged action, as to be pointed out as remarkable specimens of the healthy organ; thus making forty in the hundred free from disease. In thirty-two cases, any deviation from the natural appearance was exceedingly slight; and was, in a large proportion of them, nothing more than that mottled state which is derived from the irregular distribution of blood throughout the texture—a condition very frequently observed, where the circulation through the chest is obstructed. The instances of confirmed disease structure did not amount to above eighteen. There seemed to be no marked connection between the condition of the kidney and of the liver; for nearly one half of those cases which were stated to be remarkably healthy were coupled with the hard and probably most advanced form of the disease, while the other half occurred in cases apparently less advanced; and the more severe cases of hepatic derangement accompanied every variety of the disease in the kidney. The only two instances of fatty degeneration in the liver were in cases where the kidney was soft, smooth and white; but in another, where the liver was somewhat fatty, the kidney was hard, rough and lobulated.

“The stomach seems, in many cases, to have suffered from the excessive use of stimulants. In eighteen cases, the effects of irritation on the mucous membrane have been recorded; and as this is an organ which is more likely to pass unnoticed than the liver and some others, it is probable that this number would have been increased if its condition had been more constantly or accurately examined and noted.

“The spleen and the pancreas have very generally been mentioned as healthy.

“The intestines have, in several cases, though not very generally, shewn marked signs of disease. In about nineteen, the small intestines have been irritated in some portions of their courses—in a few of these, ulceration has taken place; and in seven cases the colon or cæcum has been diseased; but several of these have occurred in conjunction with tubercles in the lungs, and have therefore been scarcely ascribable to the peculiar circumstances of this disease.

“The diseases in the substance of the brain itself have chiefly consisted of that unequal distribution of blood which is apt to produce a mottled appearance when the medullary substance is exposed in slices, and which is frequently attendant on convulsive or apoplectic seizures. In some cases the brain has been exsanguine; and in a few, the results of such lesions as the rupture of vessels may produce, have been observed.

"The foregoing table likewise affords an instructive average of the immediate causes of death in this disease. I have been able to trace the circumstances connected with the conclusion of life in seventy cases; and find, that no less than thirty out of these seventy have died of well-marked symptoms of cerebral derangements, noted under the titles of 'apoplexy,' 'coma,' 'convulsion,' and 'epilepsy.' Eight others have died suddenly. In eight cases the obstructed condition of the lungs has been the immediate cause of death; and in three the effusion into the chest has hastened the dissolution. Next to head affections the most prevalent diseases have been inflammatory attacks in the serous membranes; amongst which are five well-marked cases of peritonitis, three of pericarditis, one or two of pleuritis. Diarrhoea and other exhausting diseases have carried off several; and in every case, except two or three, the death appears to have been the result, not of casual disease, but of such events as may be said strictly to belong to the condition of the kidney of which we have been treating.

"One other point suggests itself as capable of some illustration from the foregoing table—the period of life in which most have fallen a sacrifice to this disease, and the probable degree to which it shortens life. In seventy-four cases the age has been recorded; and of these, four only have survived beyond their sixtieth year; thirteen have passed their fiftieth year; but few of them have lived to fifty-five: twenty-one have died between forty and fifty; sixteen have passed thirty years; and nineteen have died before they had arrived at their thirtieth year: and if we take those who have died in their forty-fifth year and below that age we find that the large proportion of fifty out of seventy-four have sunk before the meridian of life. The youngest, whose age is given, is only eight, and there is one advanced to seventy-three; showing, therefore, that neither youth nor age is exempt from this disease, but that it has cut off the greater part of its victims before the middle period has been attained."

It will be observed that Bright, with the inspiration of genius, arrives at the belief that the primary cause of the symptoms in all these cases is disease of the kidneys. He points out the great importance of the function of the skin, he shows that serous effusion into the pleural, pericardial and peritoneal cavities, acute pleurisy, pericarditis and peritonitis, hypertrophy of the heart, œdema of the lungs, bronchitis, enteritis, and cerebral hæmorrhage are all accompaniments to be found in patients dying of nephritis. He shows these may be fatal, and

he tells of the terminal cerebral symptoms which we now call uræmic convulsions and coma.

Assuredly this is one of the most wonderful series of papers in medical literature. A disease, which presents symptoms of derangement of almost every organ of the body, is unerringly ascribed to the kidney. We are shown how to diagnose it. Its causes, its symptoms, its treatment and its post-mortem appearances are given with such a completeness and accuracy that after nearly a century no error has been detected in Bright's description, and, if we except a few facts that have been gleaned by instruments he did not possess, nothing of importance has been added.

Bright's enthusiasm for the study of renal disease continued, and in 1842, with the willing permission of Mr. Harrison, the famous Treasurer who did so much for the school, and with the hearty co-operation of the other physicians, the whole of both the male and female clinical wards were, from May to October 1842, set aside for the admission of cases of renal disease only, and they were under the care of Bright. This, as he says, is "the first experiment which, as far as I know, has yet been made in this country to turn the ample resources of a hospital to the investigation of a particular disease, by bringing the patients labouring under it into one ward properly arranged for observation." A small laboratory "was fitted up and decorated entirely to our purpose." Bright was helped by Dr. Barlow, who was assistant physician, and by Dr. Rees, who became assistant physician in 1843, and these two published in the *Guy's Hospital Reports* for 1843 the results of their labours, which corroborated Bright's original statements.

In the *Medical Gazette* for January 28, 1842, is a letter from Bright saying that since 1839 he and Mr. George Robinson had been making microscopic investigations of one thousand specimens of the kidneys of about one hundred patients suffering from nephritis, and that they hope to publish a work on the Anatomy and Pathology of the Kidney. As far as I know this never appeared, but Robinson, who was a student at Guy's under Bright, in 1842 published "*An Enquiry into the nature and pathology of granular disease of the kidney and its mode of action in producing albuminous urine,*" which he dedicated to Bright.

THE INTRAVENOUS ADMINISTRATION OF QUININE IN THE TREATMENT OF MALARIA

By G. NEWTON PITT, M.D., Consulting Physician to Guy's Hospital.

A VERY large amount of valuable work has been done on malaria during the war, and there have never before been such a number of cases under observation, varying so greatly in variety and intensity, and collected from so many countries and climates. This will lead to a great increase in our knowledge when the different experiences have been collated.

The intravenous administration of quinine in less than 20 c.c. of fluid is a simple and valuable method of administering the drug, which for some reason has been but occasionally employed during the war, and evidently in many cases with fear and trembling. Too often it has been reserved for semi-moribund cerebral cases and has thereby been discredited, although not infrequently it has staved off the fatal issue and rapidly restored the patient to health when other methods had failed.

It would appear that this method is greatly discouraged, if not forbidden, in India, where it is very rarely used. Inquiry suggests that this is due to a fear of tetanus, but as I have been unable to ascertain that tetanus spores have been detected in quinine, the objection at the present day, when aseptic precautions are general, is of no weight.

The Army authorities also look with disapproval on it.¹ Some thousands of patients in Macedonia, East Africa and at home have been through courses of treatment of every variety and intensity, yet in the discussion on malaria in 1918, when Sir Donald Ross collated the experience from four large Malarial Hospitals in England, dealing with 2,360 cases, less than one per cent. had had intravenous injections.²

In his book on "Malaria in Macedonia" Armand Delille³ recommends the intramuscular or subcutaneous injection of quinine in 200 c.c. of water, preferring the latter; he had abandoned the intravenous method after four trials. The use

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of large amounts of fluid in Macedonia intravenously gave unsatisfactory results; when the amount was reduced to 250 c.c. the results were much better, but that amount appears to be unnecessary and converts a simple injection into a comparatively elaborate procedure.⁴

Several officers report that they injected the quinine with 100 to 250 c.c. of water, and they found the results unsatisfactory and sometimes fatal, and consequently gave up its use.

The quantity of fluid injected and the limitation of its use to the worst cases were largely responsible for the fatal results. Some of the objections to the method may have arisen from MacGilechrist's⁵ observations of the effect of quinine on serum *in vitro* and his conclusion that two to three pints of fluid should be injected simultaneously. But the slow injection of quinine in a few cubic centimetres of water equally produces an innocuous dilute solution in the blood.

I am indebted to Dr. J. Thomson for having drawn my attention some five years ago to the innocuous and efficient administration of quinine by intravenous injection in doses of 12 to 15 grains in 15 c.c. of water. Since then he has systematically employed this method at King George's Hospital in a very large number of cases, many of which were under my care, and I have done the same at the Second London General Hospital without any ill result and with marked benefit.⁶

Thomson and others have shown that an injection given in the acute stage frees the peripheral circulation from asexual parasites within twenty-eight to forty-four hours, and if repeated the crescent forms tend to disappear after eight to ten days. It is necessary to continue with quinine in some form or other to prevent relapses. Very many of our cases had been through one or more courses of intensive treatment and had relapsed; in numerous cases the intravenous injections broke the back of the attacks and led to definite improvement. I generally made up a stock solution of bihydrochloride of quinine (4 grains to 1 c.c. of saline), which was sterilised from time to time, when necessary. Three c.c. of solution (12 grains quinine) was drawn into the syringe with a fine needle and diluted to 12 c.c. with warm saline solution. The arm was painted with 2 per cent. Tinct. Iodi, a tourniquet applied, the needle inserted into a vein at the elbow, and a few drops of blood allowed to regurgitate into the syringe to make sure the needle was in the vein. The tourniquet was removed and the fluid slowly injected, the process taking perhaps a minute. The patient might flush slightly and feel a glow of warmth over the body; he often noticed a taste in the mouth, even while the fluid was

being injected; the pulse was slightly accelerated. One or two complained of temporary giddiness, but never of any serious discomfort. The patient was kept lying down quietly for an hour or so. In two or three per cent. of cases there was subsequent local pain, and some thickening of the vein developed just above the seat of injection, but no persistent thrombosis. This was probably due to a drop of solution having escaped into the tissues, but occasionally the same thing occurred with a later injection in the opposite arm, suggesting an idiosyncrasy.

Soulie⁷ in Algiers in 1917 gave 920 intravenous injections of 15 to 20 grains of quinine in 20 c.c. of water without any ill results. He showed that the action was quicker than by intramuscular injection, and that an attack could be prevented if the injection was given four hours before it was due, while an interval of seven hours was necessary for intramuscular injections. Treatment for three to four weeks at least was necessary to prevent relapses. Patrick at Malta advocated intravenous injections of 15 grains of quinine in 5 per cent. solution for three days for first attacks. He had an exceptional number (20 per cent.) of cases of slight thrombosis and in three cases slight blackwater fever. Bacelli showed that by 10 per cent. intravenous injections the mortality of his pernicious cases was reduced from 17 to 6 per cent. Wright in Panama gave 10 grains in 20 c.c. in 258 cases without bad results.

The operation is painless, and in this way superior to both the intramuscular and subcutaneous methods, and it is always preferred by the patient. There is no uncertainty as to the amount of quinine absorbed, which may be the case with any of the other methods of administration.

Injections of 12 to 15 grains of quinine have now been given to some thousands of patients without any ill results, and my main object is to convince the profession that, properly carried out, the method is harmless and hence may be used much more frequently than hitherto, whenever there is a refractory or serious case.

It is universally allowed that in comatose cases and those with severe vomiting the oral method is unavailable and the intravenous method has met with great success. If invaluable in dangerous cases it must be of use in the less severe.

I gave the relapsing cases one intravenous injection on admission and followed it up with 30 grains daily by the mouth, once a week replacing it by an intravenous injection. There were very few relapses while the patients were under observation and almost invariably fewer than there had been before admission.

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A single intravenous injection no more prevents a relapse than an oral dose does, but three intravenous injections at the onset of the infection are said to be an extremely efficient method of cutting short the disease. In four cases of black-water fever under my care, where parasites were present in the blood and a fair amount of urine was excreted, the intravenous treatment rapidly cleared up the symptoms.

Dudgeon has shown that local necrosis is apt to occur with intramuscular injections, and indurated painful lumps and not infrequently abscesses may form. Many patients have also developed paralyses of the muscles supplied by the sciatic or the musculo-spiral nerves. None of these complications occur with intravenous injections. Manson-Bahr in Palestine found extensive sloughing of the muscles of the buttocks when several injections had been given. In spite of this Stott of Mandalay and many others recommend the method, and numerous patients had intramuscular injections during the war without ill results; the effects are certainly far more efficient than when the drug is given by the mouth. Occasionally also when the patient is very collapsed or the veins are very small, it may be difficult to inject into the vein, and the muscles may then be preferable.

The subcutaneous method is very painful and is frequently followed by the formation of abscesses, so that it should never be employed, yet the Medical Manual still recommends it.

The rectal method was the one which was chiefly employed in German East Africa for all severe cases, and with some success. But it is very irritating to the bowel, and not infrequently an examination of the urine has shown that no quinine was absorbed.

Nothing can be simpler or give a patient less discomfort than an intravenous injection if the solution is correct. It is possible that some cannot have had the right solution, when the proceeding is spoken of as dangerous and only to be used for special cases, and that 100 to 200 c.c. of solution must be injected. What is the explanation? Do the various specimens of bihydrochloride of quinine vary? Thomson noticed in making his solution that sometimes the fluid was turbid, due to its being too acid, and he added small quantities of 25 per cent. sodium bicarbonate with advantage. For months I used a most satisfactory solution, but with a new mixture supplied by the Hospital I noted that the blood on regurgitating into the syringe looked abnormal and tended to clot; when only a few minims of solution had been injected into the vein, the patient complained of being giddy and upset; the needle was

withdrawn and he soon recovered. I accordingly reverted to the specimens of quinine we had formerly used, which had been obtained from Parke Davis and from Howards, and had no difficulty with any later cases. I am not certain that this is the only explanation of the objections to the injections which have been raised, but it may be accepted that with a suitable solution there is no reason to anticipate any difficulties.

With our present experience we may hold that the intra-venous method is free from danger. It is far superior to the intramuscular and subcutaneous methods, and is to be advised in all serious cases where there are cerebral symptoms or hyperpyrexia. It is valuable in obstinate relapsing cases, and it has proved of value in some cases of blackwater fever when there has been a fair secretion of urine. The usual dose is 12 grains of bihydrochloride of quinine in 12 c.c. of saline solution, and it may in urgent cases be given three or four times in the twenty-four hours.

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ULCERATIVE COLITIS

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital.

History.—Simple ulcerative colitis appears to have been first described by Sir Samuel Wilks,¹ who pointed out in 1875 that severe ulceration was occasionally found in the colon of individuals who had never been abroad, and that although it was indistinguishable anatomically from dysentery, it must yet be a distinct disease, as the latter was accompanied by characteristic constitutional disturbances and was probably due to malaria. The study of eight cases, which had died at Guy's Hospital, was published by Hale White² in 1888, and of twenty additional cases by Cameron and Ripman³ in 1910. These authors followed Wilks in regarding the ulcerative colitis as distinct from dysentery, but believed that in most cases it was a secondary manifestation of some general toxæmia, such as that caused by granular kidney, rather than a specific and primary intestinal infection. Saundby⁴ in 1906 and Hawkins⁵ in 1909 had, however, published good clinical descriptions of the disease, which they both regarded as probably due to a dysenteric infection.

In a report on an epidemic of "idiopathic ulcerative colitis," which resulted in 118 deaths in the Lancaster County Asylum in 1898, Gemmel⁶ expressed his belief that this condition, which had always been well known in asylums, was really dysentery. Vedder and Duval,⁷ working under Flexner in 1902, proved that epidemics of "dysentery" occurring in institutions in America were caused by the *B. dysenteriae*, and two years later Eyre⁸ showed that asylum dysentery in England was also caused by this organism. As the *B. dysenteriae* is likely to be so enormously outnumbered by the *B. coli* in the stools, the isolation of the former, except at the onset of acute cases, is extremely difficult, and no bacteriologist has yet succeeded in isolating a dysentery organism in the sporadic disease as it occurs in England.

During the last twelve years Lockhart Mummery⁹ has made several important observations on ulcerative colitis as a result of his investigations with the sigmoidoscope, the use of which has entirely revolutionised our knowledge of the disease.

With the exceptions I have mentioned very little has been written on ulcerative colitis in England and in America; and in no text-book on medicine, so far as I am aware, is there an adequate description of the disease from a clinical standpoint. A review of the Continental literature is equally disappointing; the only valuable contributions I have been able to find were written by Mathieu¹⁰ in France and Adolf Schmidt¹¹ in Germany.

Ætiology.—Ulcerative colitis is a condition which occurs sporadically in England and in other countries in which dysentery is not epidemic. Young adults are most frequently affected, and the disease is equally common in men and women. It is undoubtedly infective in origin, and from the very close similarity it bears to bacillary dysentery it would seem probable that the unknown organism which causes it must be closely related to the *B. dysenteriæ*. There is no evidence connecting ulcerative colitis with oral sepsis or appendicitis, and careful investigation has failed to discover any possible primary septic focus, from which the colon could have been secondarily infected.

Ulceration of the colon also occurs in rare cases of uræmia, probably as a result of the excretion into the large intestine of toxins, which cannot be excreted by the diseased kidneys, and in mercurial poisoning. The rectum and pelvic colon may be ulcerated as a result of infection with gonococci, tubercle bacilli, streptococci or other organisms introduced per anum or invading them from neighbouring organs. None of these conditions should be included under the name of ulcerative colitis. The ulceration of the colon which occurs in typhoid and paratyphoid fever is also of course distinct, but the pathology of dysentery requires consideration in any discussion on sporadic ulcerative colitis.

Morbid Anatomy.—Sigmoidoscopic examinations at different stages of the disease and post-mortem investigations show that the primary change is an acute inflammation of the mucous membrane of the colon. Patches of localised necrosis then occur, and the gradual separation of the necrotic tissue leads to superficial ulceration. The edges of the ulcers are not undermined and the floor is formed by the submucous or muscular coat, the ulcers tending to spread superficially rather than deeply. When healing occurs new mucous membrane forms; owing to the superficial nature of the ulcers very little scarring occurs and strictures never develop. When the sigmoidoscope is passed after complete recovery from ulcerative colitis or bacillary dysentery, nothing more is seen than some very slight

puckered areas in the mucous membrane, which may be somewhat paler and smoother than normal. I have found by means of the sigmoidoscope that the appearance of the colon in the sporadic ulcerative colitis observed in England is indistinguishable from that of the colon in bacillary dysentery, thus confirming the post-mortem observations made by Wilks fifty years ago.

Symptoms.—The onset is sometimes acute with severe diarrhœa and fever. More commonly it is subacute or insidious, the first symptom noticed generally being the passage of blood and mucus with or without diarrhœa. Even in cases which appear to begin acutely a history can often be obtained of slight intestinal irregularity with the occasional passage of mucus or blood for many months, and sometimes even for two or three years, before the onset of severe symptoms.

Diarrhœa is always present sooner or later. As many as fifteen stools may be passed in the day, but in the earlier stages the bowels are only opened between two and six times. The largest number of stools is generally passed in the morning, and it is very common, as in other forms of diarrhœa, for one or more loose stools to be passed shortly after each meal, especially after breakfast. The fæces are generally fluid, but rarely watery. Sometimes the first stool passed in the day is almost solid, the others being more or less fluid. The bulk of each stool is small, especially when many are passed. When the pelvic colon and rectum are alone involved the stools may be solid, though they are rarely hard; in other cases diarrhœa alternates with constipation. Both naked-eye and microscopical examinations show that the food is well digested, except in the comparatively rare cases in which the lower end of the ileum is involved as well as the colon. Undigested starch and, less frequently, undigested meat-fibres are then found; in such cases the stools are pale and very offensive and much flatus is passed. The pus and blood cause the fæces to be alkaline unless excessive bacterial decomposition of starch occurs owing to the simultaneous presence of enteritis.

The distinctive feature of ulcerative colitis is the passage of blood, pus and mucus in each stool, and often also alone without any fæces. In quiescent periods they may appear to be absent, but chemical and microscopical examinations show that this is not the case. Blood may be passed in large quantities alone, but it is generally mixed more or less intimately with the mucus and pus. It is generally bright and red and never produces black tarry stools, such as are seen in cases of gastric and duodenal ulcer. It is mostly fluid, but small clots

are often present, and occasionally a single elongated dark red clot is passed alone. The mucus is unformed, and may be clear or opaque owing to the presence of pus; membranes are never passed. In most cases small collections of pus are easily recognised with the naked eye in addition to that mixed with the mucus and fluid fæces, but occasionally pus is only found on microscopical examination; in rare cases there is an unexplained preponderance of eosinophile cells. The amount of pus compared with mucus gives an approximate measure of the severity of the case.

Abdominal discomfort is generally, but not always, present; actual pain is rare, except immediately before defæcation, when severe colic often occurs; this disappears as soon as the bowels are opened, especially if flatus is also passed. Tenesmus is unusual and only occurs if the anal canal is involved. The abdomen is sometimes slightly distended, but in many cases it is retracted. Tenderness is often completely absent, even in severe cases, but pressure over the colon may cause discomfort. If the tenderness is considerable, the inflammation has generally spread to the peritonæum and local peritonitis is present; this is most commonly observed in the right iliac fossa (perityphilitis) and left iliac fossa (pericolitis sinistra). A moderate degree of muscular rigidity is often present in severe cases, especially when there is any local peritonitis, but it is rarely sufficient to prevent the cæcum and iliac colon from being palpable. They are almost always freely movable, and the impression of "thickening" which is sometimes given is generally due to hypertonus of the muscular coat and not to inflammatory infiltration; corresponding with this, the diameter of the palpable part of the colon is generally less than normal. I have on a number of occasions been able to verify this at operation, the tender and apparently thickened colon being perfectly normal in its external appearance and showing no true thickening on direct palpation, although in some cases the peritoneal surface is abnormally red.

Micturition is sometimes unduly frequent and may cause pain.

Digital examination of the rectum is only painful in the rare cases in which the anal canal is inflamed; in such cases spasm of the sphincter ani resists the introduction of the finger and grips it after it is introduced. The thickened mucous membrane and the ulcers are readily felt when the rectum is involved.

A sigmoidoscopic examination should always be made. An anæsthetic is very rarely required, as the passage of the instru-

ment does not cause pain, unless the anal canal is inflamed; in such cases a cocaine semple should be introduced a quarter of an hour before. If the sigmoidoscope is carefully introduced under visual guidance without inflation and only as far as it goes without difficulty there is no danger, the few cases in which perforation has occurred having all apparently been due to its blind passage. The mucous membrane is bright red, thick and sometimes slightly granular. It bleeds very readily when touched. Its surface is covered with blood-stained, purulent mucus, some of which should be removed on a sterile swab for bacteriological examination. Superficial ulcers are invariably present, but in early cases they may be so small that they are difficult to recognise. More frequently they are of larger size and are sometimes so extensive that only small islets of mucous membrane are left, which may feel like small flat polypi on rectal examination, the floor of the ulcers being mistaken for the surface of the mucous membrane. The ulcers are always superficial with irregular edges; the thick mucous membrane is not undermined. The floor of the ulcers appears greyish-yellow when the blood and mucus are wiped from their surface. In some cases the sigmoidoscope shows that the rectum or the rectum and lower part of the pelvic colon are alone inflamed, as normal mucous membrane is found higher up.

The x-rays give some indication of the extent of the inflammation. When the small intestine is not involved the cæcum is only reached after the normal interval of three or four hours. The shadow of the ulcerated colon is mottled and often abnormally narrow owing to spasm; if the cæcum and proximal colon are normal in appearance the ulceration is probably confined to the distal part of the colon.

The general condition of the patient varies considerably in different cases. In acute cases and in acute exacerbations of more chronic cases irregular fever is generally present. Apart from this the patient has generally a good appetite and resents any restriction in diet. There is no gastric ulceration and gastric analysis shows nothing abnormal. The constant diarrhœa leads to progressive emaciation and weakness, but in slight cases the patient may feel so well that he is unwilling to undergo treatment in bed. The loss of blood leads to secondary anæmia, which may be severe; the amount of hæmoglobin is often only 50 per cent. of normal and may fall to 20 per cent.; numerous nucleated red corpuscles may be present. Sir Thomas Horder tells me that he has constantly observed slight leucocytosis with a considerable relative increase in lymphocytes in the blood in ulcerative colitis, but in the only typical case I have

since seen Mr. Conybeare found a normal number of leucocytes with a normal differential count.

Complications.—The symptoms which indicate that the inflammation has spread to the peritoneal coat of the colon have already been mentioned. The evidence is not, however, conclusive, as I have seen the walls of the cæcum thick and the peritoneum obviously acutely inflamed in a case in which tenderness was completely absent. General peritonitis is very rare and is not due to perforation, but to direct spread of infection through the wall of the colon. Localised abscesses are still more unusual. In spite of the severity of the inflammation, healing of the ulcers never results in stricture.

Thrombosis of the femoral vein is said to be not uncommon, but I have never seen it myself. Occasionally multiple arthritis develops; though septic in origin, suppuration does not occur; the condition is strictly analogous to the arthritis which may follow bacillary dysentery. Multiple peripheral neuritis has also been observed.

Diagnosis.—The passage of bright blood by rectum may be due to a number of causes, which can only be distinguished from each other by thorough examination of the stools and the use of the sigmoidoscope. The association of blood in the stools with pus and mucus indicates the presence of ulcerative colitis or a growth of the pelvic colon or rectum.

In addition to the form of ulcerative colitis described above I have occasionally met with cases, the sigmoidoscopic appearance of which corresponds with Hale White's description of post-mortem specimens of the condition he called *follicular ulceration*. The whole surface of the mucous membrane is granular owing to the swollen condition of the lymphoid follicles. The degree of inflammation, as shown by redness, swelling and liability to bleed when touched, is obviously less than is generally the case in ordinary ulcerative colitis and bacillary dysentery. The apices of many of the follicles are more or less denuded of epithelium, thus giving rise to follicular ulceration. Hale White described the condition as always secondary to some other disease, the symptoms of which were so much more prominent that the colitis could not be diagnosed during life, but I have seen it occur as an independent condition, and also in cases of growth of the colon, an association first described by Lockhart Mummery.

A growth can be excluded by rectal and abdominal palpation, and by the sigmoidoscope. Even if the growth is too high to be reached by the instrument its presence is rendered very probable when the accessible part appears normal and blood,

mucus and pus are seen coming from the inaccessible part of the colon.

If the patient has been in the East the possibility of dysentery should be considered, and even in the absence of such a history it is possible that a patient may have become infected by a dysentery carrier living with him. Mucus obtained direct from the surface of an ulcer during the sigmoidoscopic examination should therefore always be examined bacteriologically, and the agglutinating power of the patient's serum should be tested against various strains of *B. dysenteriae*. I have already pointed out that the sigmoidoscopic appearance of the mucous membrane in bacillary dysentery and ulcerative colitis is identical. Amœbic dysentery is, however, so distinct that a definite diagnosis can easily be made by the use of the sigmoidoscope alone. Small, round, red elevations are seen on the otherwise normal-looking mucous membrane, corresponding with the collection of broken-down material in the sub-mucous tissue caused by the invasion of *Entamœba histolytica*. In the centre of each elevation is a depressed yellowish ulcer, corresponding to where the sub-mucous abscess has broken through the mucous membrane.

Prognosis.—Very acute ulcerative colitis may cause death in a few weeks. More commonly the condition becomes chronic with periodical acute exacerbations and thus approximates to the ordinary form of ulcerative colitis, in which the onset is insidious and the course very prolonged. Death generally results from cachexia owing to the prolonged diarrhœa and constant loss of blood. General peritonitis is a rare cause of death.

The more severe the diarrhœa, the more serious is the prognosis, as it indicates that the whole or greater part of the colon is involved. Evidence of participation of the ileum in the inflammation is of serious import, as the toxæmia is likely to be more profound. The severity of the local conditions varies more with the quantity of pus than with that of blood in the stools, but severe recurrent hæmorrhage is a very serious symptom. The extent of ulceration can only be accurately determined with the aid of the sigmoidoscope.

Treatment.—If a sigmoidoscopic examination is always made when a patient passes blood or mucus in his stools or is suffering from diarrhœa, the cause of which is not obvious, ulcerative colitis can often be recognised at such an early stage that it is still readily amenable to medical treatment. Such treatment must generally be prolonged, as no case can be regarded as cured until a further sigmoidoscopic examination has shown that all ulceration has disappeared and the mucous

membrane is no longer inflamed. The appearance seen with the sigmoidoscope gives an indication of the condition of the whole of the colon, as the pelvic colon and rectum are generally affected in the earliest stage both in bacillary dysentery and ulcerative colitis, but not in amœbic dysentery, which generally affects the cæcum and ascending colon first and most severely. When, therefore, the rectum and pelvic colon are found to be normal as a result of treatment, it can be assumed that the mucous membrane of the rest of the colon is also healthy. Symptoms frequently disappear weeks or even months before healing is complete, especially if the patient is kept in bed; this is the cause of the very frequent relapses after apparent cures, but if all the ulcers have really healed and the mucous membrane is no longer inflamed there is no tendency to recurrence.

The patient should be kept warm and recumbent in bed until no blood has been passed for a week, the bowels are not opened more than twice a day, and no ulceration and no inflammation can be seen with the sigmoidoscope. But he should continue under strict treatment till the mucous membrane appears to be perfectly normal, and he should be careful about his diet and keep his stools soft with liquid paraffin for an additional six months.

The stomach is almost invariably unaffected, and it is also rare for the small intestines to be inflamed. As digestion is usually almost complete by the time the cæcum is reached, the diet is consequently of less importance than might be expected. If the food is thoroughly chewed a light mixed diet is permissible, and if, as is often the case, the patient has lost weight, two or three pints of milk should be given in addition. The food must be thoroughly masticated. Everything which could irritate the colon mechanically should be prohibited; vegetables are only allowed if they have been passed through a fine sieve and no fruit except in the form of jellies should be given. Tough meat, porridge and whole-meal brown bread are prohibited. At one time I always prescribed milk, which had been soured with a reliable lactic acid-producing bacterial culture, but I do not think it exerted any obvious effect on the course of the disease. Pyorrhœa alveolaris and other sources of sepsis in the mouth, nose or pharynx should be removed, as they might aggravate the condition by leading to secondary infection of the ulcerated colon.

The colon should be irrigated every day. After having tried a considerable number of astringent and antiseptic drugs in the local treatment of ulcerative colitis I came to the conclusion that the best is albargin, a preparation of silver nucleinate, which Rogers had found the most effective in dysentery. During

the war albargin became increasingly difficult to obtain and the English stocks were finally exhausted towards the end of 1915. I then tried silver nitrate again, but it caused too much pain, and I finally employed tannic acid as the best substitute for albargin, the strength being gradually increased from gr. $\frac{1}{2}$ to gr. 2 to the ounce. This proved more effective than plain saline solution and much less painful than silver nitrate, but I am convinced that albargin is still better, and since it has become obtainable once more I always use it.

The technique of giving an intestinal douche might seem a trivial matter, but I find that nurses are wrongly instructed on the subject, and that the results obtained depend very largely upon the way the fluid is introduced. It is generally taught that a so-called "high enema," one which is intended to reach the proximal parts of the colon, should be introduced through a long tube inserted as far as possible through the anus. At spas where the Plombières treatment is given the tube is generally passed eighteen inches. Forty years ago Sir James Goodhart proved in the post-mortem room that it is impossible to pass a tube beyond the fixed part of the rectum, and some observations I made in 1909 with the x-rays after passing a rubber-tube, filled with a bismuth salt, showed that this is also true in the living subject. Fig. 1 is reproduced from a skiagram taken by Dr. P. Briggs; it shows how the tube invariably turns back when it reaches the pelvi-rectal flexure—the acute angle formed by the junction of the movable pelvic colon with the fixed rectum, and then coils round the rectum. This is only what one would expect after passing a sigmoidoscope and observing the blank wall facing the tube four and a half inches from the anus where the fixed rectum ends; the instrument requires very careful manipulation with the aid of direct visual observation to get it round the flexure. This is of great practical importance, as if a rubber-tube is pushed eighteen inches into the rectum, as is too often done, it curls round and scrapes the mucous membrane, the inflammation and ulceration of which are actually aggravated. Even when there was no inflammation or ulceration before the treatment began, proctitis may be caused in this way. I believe that this is one reason why so many patients, who have never passed mucus before, begin to do so after they have received a course of Plombières douches at a British or foreign spa. Ten years ago Mathieu pointed out that more cases of colitis are produced at Plombières than are ever cured there, and I think the same is true to-day with regard to certain English spas. I have seen three cases in which the sigmoidoscope showed that the whole rectum was inflamed.

and secreting excess of mucus, whereas immediately beyond the pelvi-rectal flexure the mucous membrane was perfectly healthy. Nothing was needed to cure the patients beyond the discontinuation of the rectal douches they had been given for some weeks through tubes passed twelve or more inches beyond the anus.

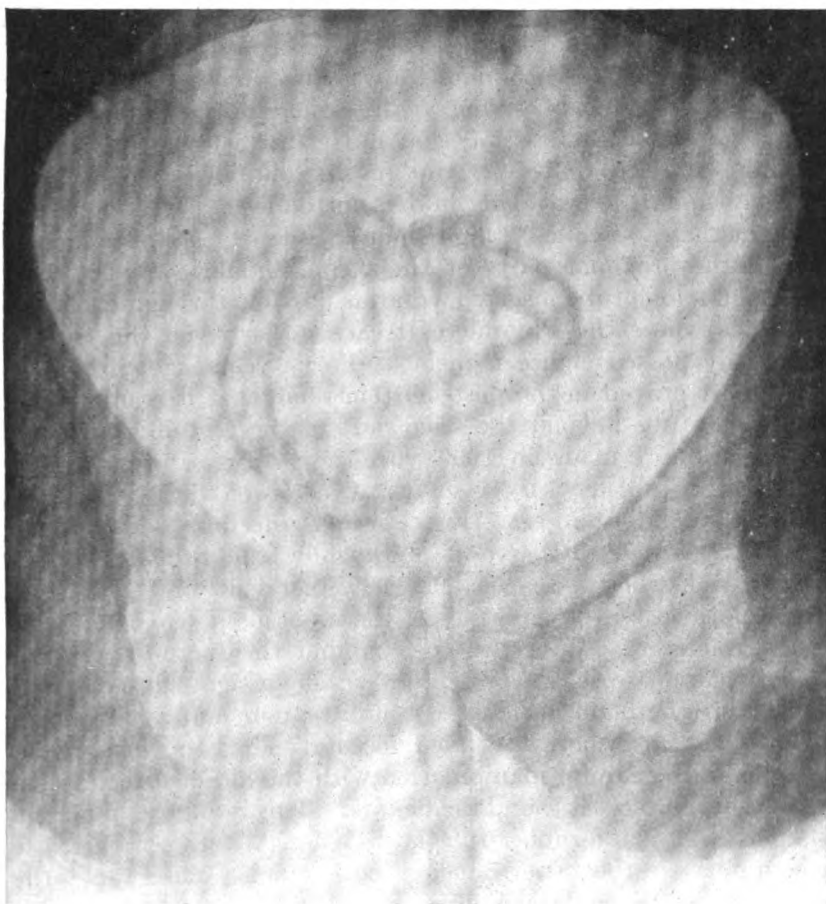


FIG. 1.

Rubber tube inserted eighteen inches beyond the anus coiled up in the rectum.

The tube, which should have a hole at its end, should therefore be inserted just within the anus and never further than an inch and a half. This also applies to the use of a rectal tube passed with the object of allowing gas to escape from a distended colon.

In order that the fluid should reach the surface of the ulcers the colon should be as empty as possible before it is injected.

The treatment should therefore be given, whenever possible, after the bowels have been opened naturally; if in the later stages of treatment there is a tendency to constipation, sufficient liquid paraffin should be given to make this occur. In any case an injection of a pint and a half of warm water should be given about half an hour before the albargin in order to clear away the remaining fæces, blood and mucus; this should only be retained for about five minutes.

A pint and a half of the albargin solution should be run in very slowly at a pressure of not more than twelve inches of water. The patient should be in the knee-elbow position with the thighs perpendicular to the bed, the back as concave as possible and the shoulders resting on the bed; in this way the natural obstruction at the pelvi-rectal flexure is much reduced. Consequently fluid runs more easily out of the rectum into the pelvic colon; the rectum does not get distended, so that the urgent desire to evacuate the fluid, which generally occurs if the patient is in the usual lateral position, does not occur.

I have found with the x-rays that fluid injected in this way invariably reaches the cæcum, so that the whole of the ulcerated mucous membrane is treated, as the ileum is rarely, if ever, affected. The fluid should be retained for gradually longer periods up to an hour. If the tube with its attached funnel is kept in position there is rarely any difficulty about this, as the patient can allow some of the fluid to escape temporarily if he finds it difficult to retain.

When the patient is very ill as a result of long-continued loss of blood from the colon, all treatment is likely to fail unless his general condition improves. Transfusion of blood is of remarkable value in such cases, a patient who was almost moribund before sometimes recovering sufficiently to be able to stand vigorous local treatment, which ultimately results in cure.

It is always advisable to examine the stools bacteriologically and to test the agglutinating power of the blood serum against the different organisms found. In my experience, however, vaccine treatment has generally very little effect, doubtless because of the extreme difficulty of discovering the organism which is really responsible for the colitis. If it can be identified with certainty vaccination may be tried in addition to, but never as a substitute for, other treatment.

I was much struck in Salonica by the extremely good results obtained in acute bacillary dysentery with large doses of polyvalent anti-dysenteric serum injected intravenously. I have tried the same treatment in two chronic cases. In one the

patient was so ill that appendicostomy had to be performed at the same time; death occurred after a temporary rally, but the patient had been very ill for four years, and on his discharge from a military hospital three years before he had not been expected to live for more than two or three weeks. In the following case, however, the improvement was so striking that there is no doubt that all cases of chronic bacillary dysentery should be treated in this way.

Bacillary dysentery of two years' duration; intravenous injections of anti-dysenteric serum; rapid recovery.—Henry W., aged thirty-five, whilst serving in Salonica had an attack of acute dysentery in December 1918. He was admitted into hospital: bacteriological examination of the stools was negative on the first two occasions, but on the third Flexner's *B. dysenteriae* was isolated. Up to this time he had been treated with emetine, but it had aggravated his symptoms. He was now put on starvation diet, given sodium sulphate in large doses, and had daily lavage of his colon with potassium permanganate solution. He was discharged from hospital in March 1919, and sent to England. There was now no blood in his stools, but he still had a tendency to diarrhoea. Severer symptoms appeared in June 1919, but in two months he was again better. In March 1920, the old symptoms returned and gradually got worse. His stools became increasingly frequent and looser, and blood and mucus were invariably present in them. By September he was passing as many as seven stools a day, and on September 12 he passed half a pint of bright red blood. He was admitted to Guy's Hospital under my care on September 13, 1920. His stools consisted of bright red blood, mucus and pus, which was easily recognised by the naked eye. Small quantities of liquid faeces were present in some, but not all, of the stools. Nothing abnormal was found in his abdomen, and there was no tenderness or rigidity. On rectal examination numerous ulcers could be felt. He was sigmoidoscoped the day after admission, and innumerable shallow, irregular ulcers were seen, the surfaces of which were covered with purulent mucus. The intervening mucous membrane was swollen and very red, and bled directly it was touched. A swab taken from the surface of an ulcer during the sigmoidoscopic examination showed the presence of an aberrant type of Flexner's *B. dysenteriae*.

The patient was given intravenous injections of polyvalent anti-dysenteric serum, beginning with 40 c.c. on September 21, the dose being increased by 10 c.c. each day until he received 100 c.c. on September 27 and 28. The Lister Institute polyvalent serum was used, as on my return from the East in 1916 I

had supplied the Institute with a collection of cultures obtained from Salonica cases to be used in the preparation of its polyvalent serum. In addition to the serum treatment he was given colon douches of albargin solution and charcoal by mouth. By October 1 the stools were semi-solid and contained neither blood nor pus and very little mucus. On October 7 a second sigmoidoscopic examination showed that every ulcer had healed and that the mucous membrane was now only very slightly inflamed. Small depressed whitish areas were seen, which presumably represented scars of the healed ulcers. By October 11 the stools were normal and no dysenteric organism could now be isolated. Full diet was allowed and the stools appeared to be quite normal. The bowel irrigations were now stopped and the patient was allowed up. When a further sigmoidoscopic examination was made on November 11, the mucous membrane looked perfectly healthy, except for the faint scars. The patient was discharged on November 6 feeling perfectly well, and in spite of his restricted diet he had gained almost exactly a stone in weight during the eight weeks he was in hospital. I saw him again on December 6; he looked and felt perfectly well, and nothing abnormal could be seen with the sigmoidoscope.

The remarkable result obtained in this case encouraged me to try the effect of the same treatment in a very severe case of sporadic ulcerative colitis, which was under my care at the same time. No dysenteric organism was found in his stools and the patient's blood did not agglutinate any of the common strains of the dysenteric bacilli, but recovery was even more rapid and complete than in the case described of bacillary dysentery.

Acute ulcerative colitis cured by anti-dysenteric serum.—Cedric D., aged twenty-one, had several attacks of diarrhoea in the summer of 1919. A few weeks after the onset he noticed blood and mucus in his stools. His motions gradually became more loose and frequent, and his general health deteriorated. He was kept in bed after August 1920, and was given olive oil enemata and a very light diet. No improvement occurred, and early in September he was given injections of emetine, as it was suggested he might be suffering from amœbic dysentery. His condition was, however, greatly aggravated by this, and he passed much more blood, pus and mucus, and had almost continuous nausea. I first saw him on October 1, 1920. He was very emaciated, had a high temperature, and complained of a moderate amount of pain; there was some general abdominal tenderness. He passed as many as a dozen stools in a day, each of which contained blood, pus and mucus. He had lost

three stones in weight during the previous six weeks. He was very pale and looked ill. The sigmoidoscopic examination showed that the colon was in exactly the same condition as in the case of bacillary dysentery just described. As he was so ill, I recommended that an appendicostomy should be performed without delay. The appendix was, however, very adherent; the stoma did not prove satisfactory, and considerable quantities of fluid fæces escaped from the opening. The colon was washed out continuously for forty-eight hours through the stoma with saline solution and afterwards with albargin, but the patient's condition became steadily worse. A bed-sore developed on his sacrum, and there seemed little doubt that he would die soon if nothing more was done. Sigmoidoscopic examination on October 11 showed that no improvement had occurred. Very large quantities of blood were passed by rectum; on October 12 a blood count showed 2,700,000 red corpuscles per cubic mm., and the hæmoglobin percentage was 84. No dysenteric organism was found in any stools, and his serum did not agglutinate any stock dysenteric organism. The patient's condition was so grave that it became necessary to transfuse him. On October 14 he was given 500 c.c. of his father's blood; the beneficial effect was immediate. From October 18 onwards he was given intravenous injections of polyvalent anti-dysenteric serum, beginning with 40 c.c. and increasing the dose every day by 10 c.c. until 100 c.c. were given on October 24. By October 21 blood had already disappeared from the stools, which rapidly became more solid, and by October 26 no mucus was present. On October 23, *five days after the first injection of serum*, a sigmoidoscopic examination showed that the mucous membrane was already entirely free from ulcers; very slight scarring was observed and the colour was slightly redder than normal. At a further examination made on November 1 the mucous membrane was found to be perfectly healthy. He was given full diet from October 31, and was allowed up on November 2. Blood examination of November 5 showed that the red corpuscles now numbered 4,860,000 per cubic mm., and the hæmoglobin percentage was 72. The patient felt and looked entirely different. He was discharged on November 17, having gained a stone in weight in four weeks. His stools were now quite normal. The appendicostomy opening had not been used since the serum treatment began, but it was not quite closed on discharge.

The only additional case of ulcerative colitis I have since seen responded with almost equal rapidity to treatment with

serum. She was a woman of twenty-six, who had never been abroad, and no dysentery organism was isolated. The symptoms had begun about eighteen months before, and very extensive ulceration was seen with the sigmoidoscope. Six weeks later the stools were normal and the mucous membrane healthy.

Intestinal antiseptics given by mouth have very little, if any, effect; if sour milk is given they would probably diminish or totally prevent its activity. When the diarrhœa is particularly severe opium or its alkaloids may be required.

The administration of large doses of charcoal leads to the absorption of gas and a great diminution of any colic which is present, as the latter is almost invariably caused by intestinal flatulence. At the same time if the stools are offensive, which is not very common in ulcerative colitis, they become odourless. Possibly bacterial activity is reduced and toxins are absorbed by the charcoal, as the general condition of the patient appears to benefit considerably when it is given. Half an ounce of very finely powdered animal charcoal should be taken in milk or arrowroot, sweetened with a little sugar, the last thing at night, and in severer cases two or three times a day.

When for any reason a patient is not willing to undergo prolonged medical treatment, which generally necessitates at least six weeks in bed and often six, nine or more months, when medical treatment does not produce rapid improvement, and finally when the case is already chronic or of considerable severity on first coming under observation, the question of operation requires consideration. The only radical surgical measure would be excision of the affected part of the bowel, but this is rarely, if ever, possible as the ulceration almost always extends to the rectum, so that complete excision is impossible. For the same reason short-circuiting operations are useless; they are also very dangerous as the distal segment is inflamed.

The ideal operation is appendicostomy, or, if the appendix has already been removed, a valvular cæcostomy which allows the introduction of fluid through a catheter but not the escape of fluid fæces. The colon should be washed out continuously for forty-eight or seventy-two hours with saline solution introduced drop by drop through a catheter and allowed to escape from a bed-pan, upon which the patient lies. The pan is fitted with a side tube which allows its contents to run into a receiver on the floor. After this the colon is washed out with plain water once a day, and when all the fluid has escaped the albargin solution already mentioned is introduced and allowed to escape when the patient wishes. The treatment is otherwise the same as

without operation, but improvement is generally more rapid, and complete recovery is likely to occur in about half the time. The stoma should not be allowed to close until the sigmoidoscope has shown that the mucous membrane has completely healed. Although it would be reasonable to expect that washing the colon out from above would be more efficacious than from below, the operation is not, however, always followed by satisfactory results. In one case at any rate the patient appeared to be going steadily downhill until the opening was allowed to close and treatment from below was substituted. In some cases, too, it may be impossible to perform the operation satisfactorily owing to the abnormal condition of the appendix or to the presence of adhesions in the neighbourhood. If treatment with antidyenteric serum proves as successful in the future as might be expected from the cases recorded above, the necessity for any operation should eventually become very rare.

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STUDIES IN GASTRIC SECRETION

INTRODUCTION

By J. A. RYLE, M.D., Assistant Physician to Guy's Hospital.

IN 1914 Rehfuß¹ gave an account of a technique for obtaining a continued record of the secretory functions of the stomach with the aid of an Einhorn's tube or modifications thereof. Together with his co-workers he established the value of the method, which is now customarily described as the fractional method of gastric analysis, and published the results of numerous observations both in healthy subjects and in sufferers from various gastric disorders. Other observers in America have also reported on physiological, pharmacological and pathological findings obtained by applications of the fractional test.

In January 1920 the writer started to review the method both as a means of studying normal gastric physiology and as an aid to clinical diagnosis. With the exception of a few personal physiological experiments the greater part of his investigations have been confined to patients presenting gastric symptoms, but a very important and extended series of observations on healthy student-volunteers has been made by his colleague, Dr. T. I. Bennett. For a proper appreciation of the results of these parallel inquiries into gastric secretion in healthy and diseased subjects, an understanding of the technique employed is essential.

The apparatus is of the simplest. During the earlier part of the year an Einhorn's duodenal tube (Fig. 1) was always used, but latterly a slight modification constructed for the writer by Messrs. Down Brothers (Fig. 2) has proved even more satisfactory. It consists of a small-bore rubber tube with a blind end, into which is inserted an oval weight of lead. Just above the weight holes are punched in the rubber tube, which is also marked at levels corresponding with the distance from the teeth to the cardia, the fundus and the pylorus respectively.

The advantages claimed for this tube are (1) that it is on the whole more easily swallowed and withdrawn; (2) that, owing to the fact that the apertures lie in an elastic instead of a rigid wall, blockage with mucus plugs is obviated, or if it

occurs the plugs can easily be expelled by a syringe of air; (3) that there is no possibility of the end becoming detached; and (4) that there is less likelihood of trauma to the gastric mucosa. Further the tube is cheaper to manufacture.

The only other pieces of apparatus required are a small plug for the upper end of the tube to prevent syphonage during the test, a ten or twenty cubic centimetre Record or all-glass syringe, and a rack containing twelve test-tubes. For the analysis the ordinary burettes and reagents are employed.

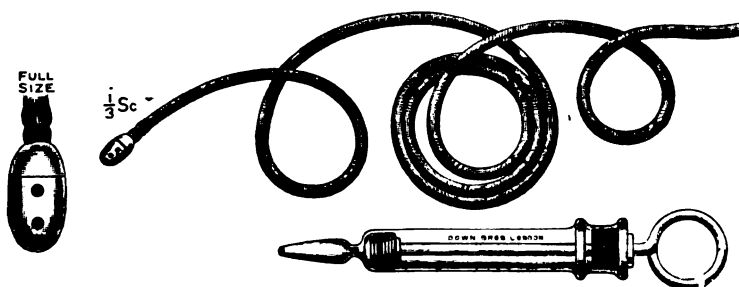


FIG. 1.

Einhorn's Duodenal Tube.

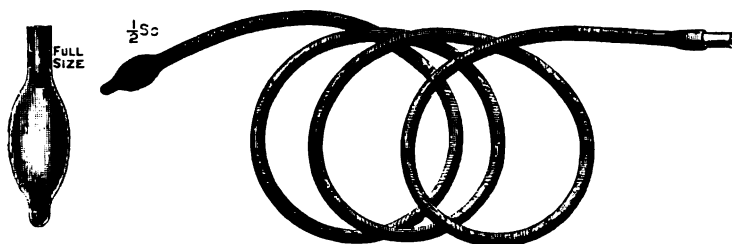


FIG. 2.

Author's modification of Einhorn's Tube.

PREPARATION AND TECHNIQUE

The patient is directed to take no food or drink after 9.30 p.m. on the evening before the test. At 9.30 a.m. he swallows the tube to the fundus level, and all the resting secretion is withdrawn and measured. Slow and gentle suction only should be exerted in removing specimens. He then drinks one pint of oatmeal gruel prepared according to a fixed recipe.* Women find a full pint rather excessive.

At intervals of a quarter of an hour thereafter specimens

* Mix two tablespoonfuls of breakfast oatmeal with one quart of water. Boil slowly down to one pint. Strain through muslin. Add salt to taste and give warm.

of about 10 c.c. in bulk are aspirated with the syringe until the stomach is empty. The indications of approaching emptying are the withdrawal of small or frothy specimens, even when the tube is raised or lowered, and the appearance of bile.

After the withdrawal of each specimen a little air should be blown down the tube to clear it, and the syringe cleaned with water.

In directing both the swallowing and the withdrawal of the tube it should be remembered that there is a tendency for the bulb to stick at the constriction corresponding with the level of the cricoid. With explanation and encouragement not to be in too great a hurry and to draw deep, steady breaths through the nose between the acts of deglutition, there should be no failures in the introduction of the tube. Pronounced salivation and nausea during the test are not frequent, but when present, allowances must obviously be made in the subsequent interpretation of the readings.

After sedimentation in the test-tubes has occurred, rough naked-eye estimations of the gruel-content and of the amount of mucus and bile in each specimen are made. The presence of blood should also be recorded.

The ordinary titrations for determining the free and total acidity, using 5 c.c. samples, are carried out, and the time of disappearance of starch—which gives the rate of emptying—is noted by adding iodine to the residue in the tubes.

The percentage readings of the free and total acidity are finally plotted on a special chart, and a curve expressing the secretory activity of the stomach throughout the cycle of gastric digestion is thus obtained.

In the wards and out-patient department at Guy's Hospital the fractional test-meal is now generally employed in preference to Ewald's one-hour test. Though rather more tedious, it causes less discomfort for the patient, but its chief advantage undoubtedly lies in the very much fuller information concerning gastric function which it provides.

The writer and his colleagues are indebted to Dr. A. F. Hurst for much advice and encouragement throughout the investigations reported in these studies. They also wish to express their appreciation of the invaluable assistance which has been given them and is still being given by numerous students of Guy's Hospital.

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I. THE HYPERSECRETORY CURVE AND ITS INTERPRETATION

By J. A. RYLE, M.D., Assistant Physician to Guy's Hospital.

IN the course of the routine investigation of cases of dyspepsia by means of the fractional test-meal curves expressing the acid-secretion are obtained in great variety. In healthy subjects it has been shown by T. I. Bennett¹ that at least four types can be recognised, and that variations occur not only in respect of the actual limits of acidity but also in the general conformation of the curves. In the case of dyspeptics, as might be expected, these variations are more numerous and even more difficult of interpretation, and excepting in certain well-defined groups, do not at present repay any attempt at detailed analysis. Their complexity does not in itself call for comment, and it is sufficient to bear in mind that differences in motility and the rate of emptying, in the amount of neutralisation by reflux from the duodenum, by swallowed saliva, and by mucus secretion, and above all, in the rate of acid secretion itself, are all factors liable to modify the serial percentage readings.

In 30 or 40 per cent. of unselected cases of dyspepsia examined by the fractional method, the readings fall within the average normal range. In about 25 per cent. there is obtained a definite "hyposecretory curve," and of these about one-third show complete a-chlorhydria throughout the cycle of gastric digestion. In the remaining cases definite hypersecretion is demonstrable.*

In this last group one type of curve (charts I, II and III) is encountered with considerable frequency. Its characters are so striking that they would seem to require a careful review, more particularly as the curve is often obtained in cases showing a special train of symptoms. With the exception of achylia gastrica there is no class of case in the writer's experience which gives a curve so consistently true to type.

In most instances it has been obtained from patients with history, symptoms and sometimes x-ray findings pointing to a diagnosis of duodenal or pyloric ulcer; a definite account of previous melæna or operation has given confirmatory evidence in a few cases. Similar curves have also been obtained in other dyspeptic conditions in which there has been no reason to

* No finality is claimed for these figures. They represent the incidence of the several types of secretory curve in a series of upwards of 100 consecutive, unselected cases examined by the writer in the past year.

suspect the presence of an actual duodenal or pyloric ulcer; cases of probable reflex dyspepsia from some other intra-abdominal lesion, a case of tabetic crises, and certain cases with a probable emotional basis have shown curves not widely dissimilar from that which it is the special purpose of this paper to discuss. The most striking examples have, however, been associated with "duodenal" or "pyloric" symptoms.

Definitely proven cases of lesser curvature ulcer, on the other hand, in the writer's series have all shown normal or hyposecretory types of curve, and in a few instances almost complete a-chlorhydria.

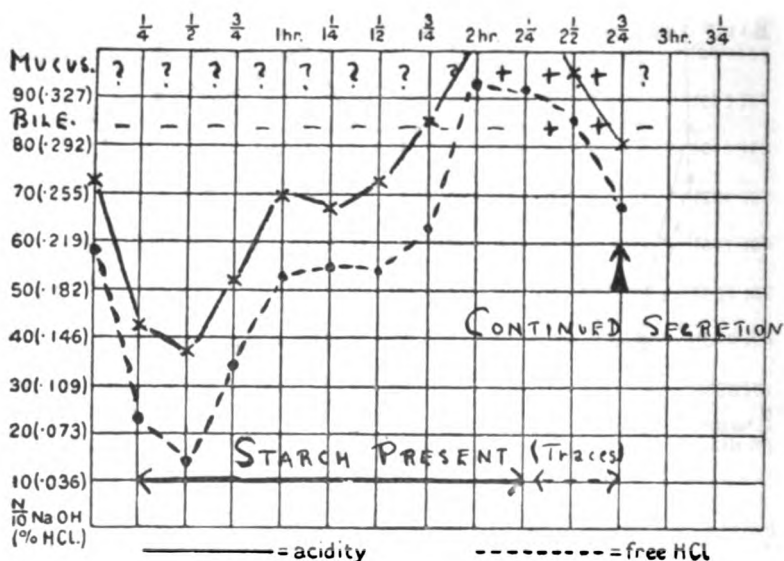


CHART I.

From a case of duodenal ulcer (clinical diagnosis). Pain 2 1/2 hours after food.

In Bennett's healthy series a few examples in the hypersecretory group approximated to the type to be described.

The outstanding points in gastric analyses which reveal this curve may be summarised as follows—

(1) There is a very copious, clear resting-secretion, 60, 80 and upwards of 100 c.c. being commonly withdrawn without any difficulty.* Mucus is present in smaller proportion than

* Rehfuss² claimed on the basis of experiments on 100 normal individuals that the resting juice varied in amount between 23 c.c. and 160 c.c. with an average figure of 52 c.c. In the writer's experience figures above 50 c.c. have been unusual in normal subjects and also in other than frankly "hypersecretory" dyspeptics, particularly if care be taken to avoid the withdrawal of duodenal secretion together with the resting gastric content.

normally, and the juice on standing may be clear instead of turbid or opalescent. The acidity is high, showing readings from 50 to 80.

(2) Following the initial drop to a low figure or even to the base-line, resulting from dilution with the test-gruel, the curve of acidity shows a steady and more or less steep ascent to a point as high as or higher than that of the resting-juice, often reaching 70 or 80, and in a few instances 90 or 100. The

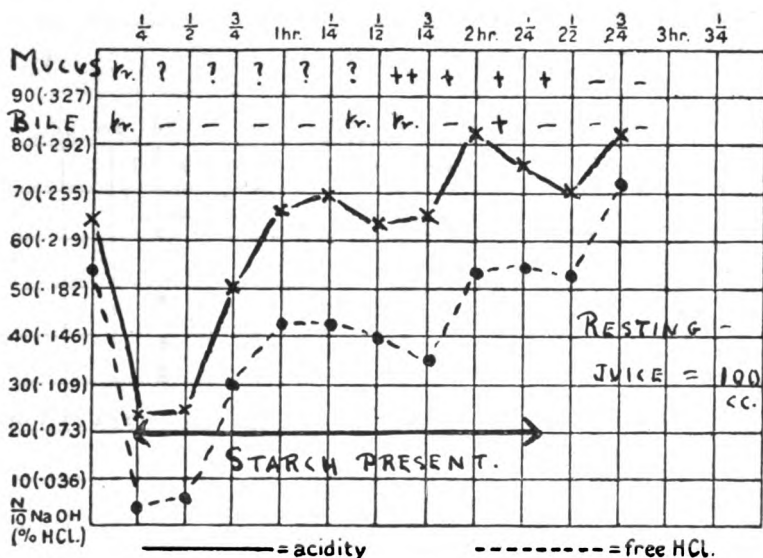


CHART II.

From a case in which clinical features and pain localisation to the left of the mid-line suggested to several observers a diagnosis of gastric ulcer. X-rays on the first occasion showed some angulation of pylorus and slow emptying, but on the second occasion showed no evidence of ulcer. Faeces gave a negative guaiac test. On strength of curve a diagnosis of pyloric or duodenal ulcer was suggested. Operation revealed a large chronic ulcer extending from the pylorus for one inch or more into duodenum.

average of the highest points in ten cases was 73. After this point is reached the curve may show a sustained plateau (chart III) or a drop to a figure approximating to that shown by the resting-juice (chart I).

(3) The summit of the curve coincides fairly closely with the time of emptying, as estimated by the disappearance of starch from the specimens, and the succeeding samples are usually copious and very clear.

The rate of emptying varies within wide limits. In the majority of cases it is between two and two and three-quarter

hours, but in a smaller group showing "duodenal hurry" emptying may be complete in periods lying between three-quarters of an hour and one hour and a half. The average rate in healthy subjects is two and a quarter to two and a half hours.

The deductions to be drawn from these findings which at once suggest themselves are as follows—

(1) In the copious, clear resting-secretion and the plentiful post-prandial output, we have evidence of hypersecretion on the part of the gastric glands.

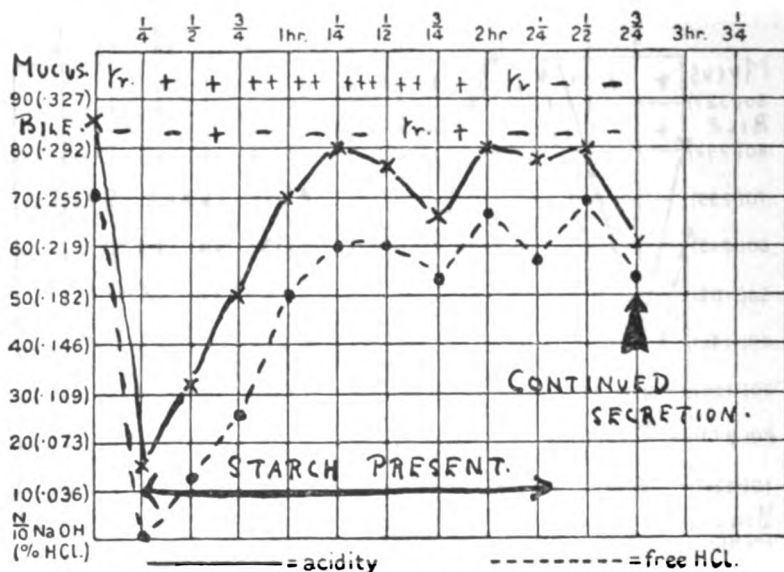


CHART III.

Duodenal ulcer (clinical diagnosis). Shows sustained plateau and continued secretion.

(2) In the high acidity of the resting-juice and the post-prandial secretion, in the relatively low proportion of mucus, and in the steep climb in the acid-percentage, we have evidence that secretion is in any case proceeding at a rate too great to be countered by such neutralising factors as regurgitation from the duodenum and the secretion of mucus.

(Some such contention as this is necessary to support the view advanced by Pavlov and now fairly well established by animal and human experiment that gastric juice has a constant acidity for the individual. The total acidity of the appetite-juice of man, according to Carlson,³ lies in the neighbourhood of 0.5 per cent. HCl.)

(3) In addition to hypersecretion there is, in the cases with slow emptying, probably pyloric hypertonus,* with the result that hypersecretion is taking place into a volume of gruel slowly diminishing, so that the acidity shows a steadily climbing percentage (charts I, II and III). In the smaller rapid group general hypertonus prevails, hypersecretion takes place into a quickly diminishing volume, and the curve of acidity shows an even steeper ascent and a more rapid completion (chart IV). Whether emptying be slow or rapid, neutralisation by duodenal reflux is effectually prevented by pyloric hypertonus on the

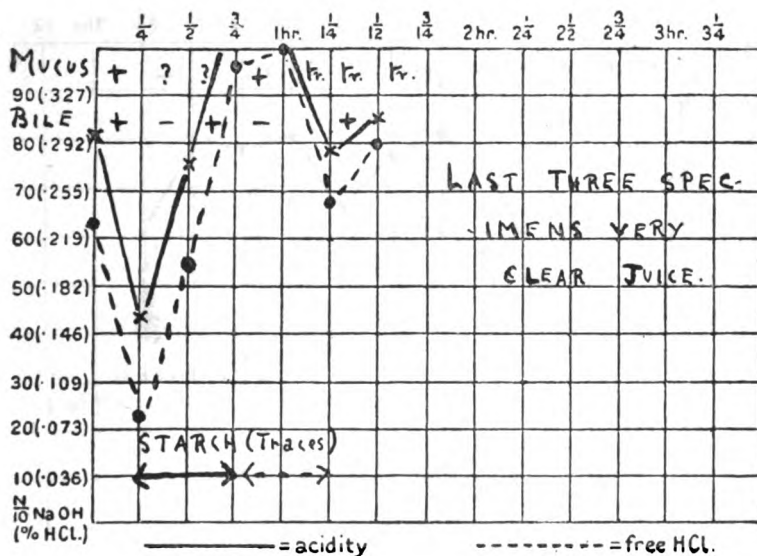


CHART IV.

Duodenal ulcer with "hurry." Such high readings for free acidity are exceptional.

one hand, and the rapid ejection of stomach-contents on the other.

In the slow-emptiers it might be urged that there is no need for the pyloric hypertonus hypothesis, since secretion is proceeding so rapidly that the stomach has actually a much larger bulk than the original pint of gruel to evacuate, and the time of emptying must in consequence be prolonged. On the other hand, radiographic observations in these cases commonly show very active peristalsis, which, in the absence of pyloric hypertonus, should tend to bring about quick emptying.

* The term hypertonus is employed not so much to imply spasm as a diminished tendency to relaxation. Pyloric achalasia is a suggested alternative.

The fact that the acidity towards the end of the meal may reach a higher figure than that shown by the resting secretion necessitates the contention that the latter is exposed to more of the natural neutralising factors, while the juice at the peak of the curve and the moment of starch disappearance is the nearest approach to pure juice secreted in response to a food-stimulus that can be obtained.

Excepting in cases of pyloric stenosis the test-tubes on standing show a steadily decreasing content of gruel as the meal progresses, but at a point close to the peak of the curve emptying becomes complete so far as food is concerned, and

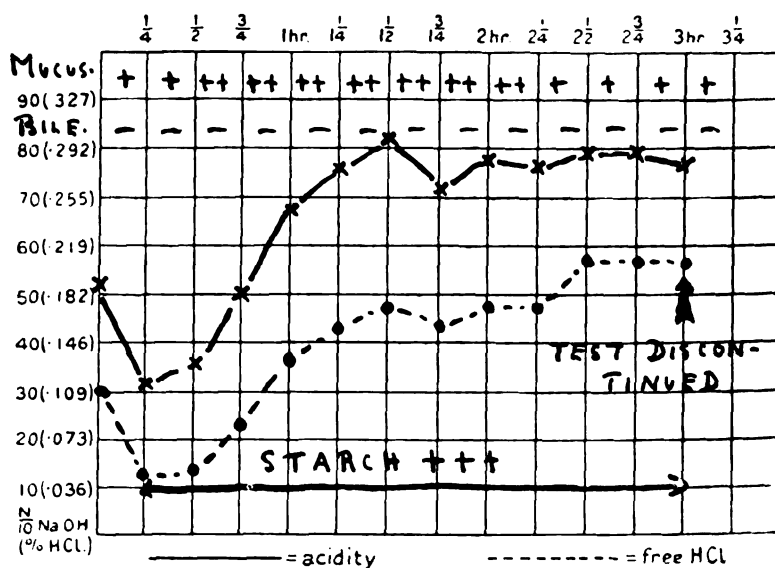


CHART V.

Pyloric stenosis due to ulcer. Confirmed by x-rays and operation.

the succeeding specimens are copious and clear, suggesting a re-establishment of more complete tonus following a sufficient relaxation to allow of the exit of the meal.

On the findings described the presence of hypersecretion would seem to be beyond dispute, and in fact it has long been recognised that cases of pyloric and duodenal ulcer show hypersecretion more constantly than any other condition. "Il n'y a pas d'ulcère gastrique et, plus particulièrement encore, d'ulcère de localisation pylorique ou juxta-pylorique sans hypersecretion."⁴

In support of the pyloric hypertonus theory we find that almost identical curves, with the exception that emptying does

not take place or is greatly delayed, may be obtained in cases of actual pyloric stenosis due to ulcer (chart V). The collection of large quantities of resting-juice is also suggestive of a tonic pylorus, at any rate between meals. The fact that hyperacidity is less common in lesser curvature ulcers may be attributable to the absence of pyloric hypertonus and the consequent neutralisation by duodenal reflux.

Finally the recording of these curves in cases of duodenal or pyloric ulcer, in which pylorospasm is held to be a common feature and even the cause or a contributory cause of the pain, seemed to lend plausibility to the theory. Pain probably occurs when hypertonus passes into actual spasm in the presence of undiluted juice, that is to say, in the neighbourhood of the high peak of acidity.

The fact that the time-relationship of the pain is so variable probably depends upon the variability in the rate of emptying.

In the writer's series of dyspeptics "hypersecretion" occurs more than twice as frequently as in Bennett's series of normals. Hypersecretion in itself may therefore be of pathological significance. The association of hypersecretion with a curve of this conformation would appear to be more definitely pathological.

It may even be that the curve is the graphic expression of the presence of some irritative phenomenon, local as in ulcer, distal as in appendicitis, or central as in tabes, but in each instance tending to give rise to hypersecretion and hypertonus through vagal stimulation. A copious resting specimen with a free acidity of 60 or over would appear to allow a safe prediction that a curve of this type will be obtained.

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II. ON THE EFFECT OF WATER AS AN EXCITANT OF GASTRIC SECRETION, WITH SPECIAL REFERENCE TO ITS APPLICABILITY AS A TEST-MEAL

By P. McG. MOFFATT, G. O. MITCHELL and A. T. W. POWELL.
(From the Physiological Department, Guy's Hospital.)

VERY contradictory opinions are expressed in text-books of physiology as to the effect of water on the gastric secretion. Thus the work of Edkins¹ on the gastric hormone is based on the assumption that water introduced into the stomach produces no flow of hydrochloric acid, and if the assumption be incorrect the whole of the subsequent conclusions are invalid. On the other hand, both Roger² and Gley³ state that a large amount of water will produce a secretion, whereas a small one will not.

In 1914 and 1915 Carlson, Orr and Brinkman,⁴ and Reh fuss, Bergeim and Hawk,⁵ brought forward evidence, obtained by the fractional method, that a very definite secretion of hydrochloric acid can be induced by water in the human subject, claiming that the acid produced was as great as that obtained by the tea-and-toast meal, and that the figures were constant for the individual. These workers suggested the use of water as a routine test-meal in the investigation of pathological cases.

The question was more closely investigated by Austin,⁶ who failed to obtain such high figures of acidity in normal subjects, but reported favourably on the applicability of water as a test-meal; single estimations only were made in his work.

In order to test these varying views we have carried out a series of investigations on ourselves and are able to draw the following conclusions—

(1) In a given individual notable variations in the amount of hydrochloric acid produced by a water-meal of given volume occur from day to day.

(2) Of five healthy normal subjects investigated two showed complete achylia with a water-meal on several examinations; these subjects with a gruel-meal gave a constant curve of acid of average height.

(3) Regurgitation of bile appears to be more frequent with a water-meal than with a gruel-meal, but is not alone responsible for the achylia seen in the above cases.

(4) The precise rate of emptying is far more difficult to estimate with the water-meal than with the gruel-meal.

These conclusions seem to us sufficient to dismiss the question of the applicability of water as a test-meal.

Chart I shows a typical series of curves of the secretion of free hydrochloric acid evoked by water and by oatmeal gruel.

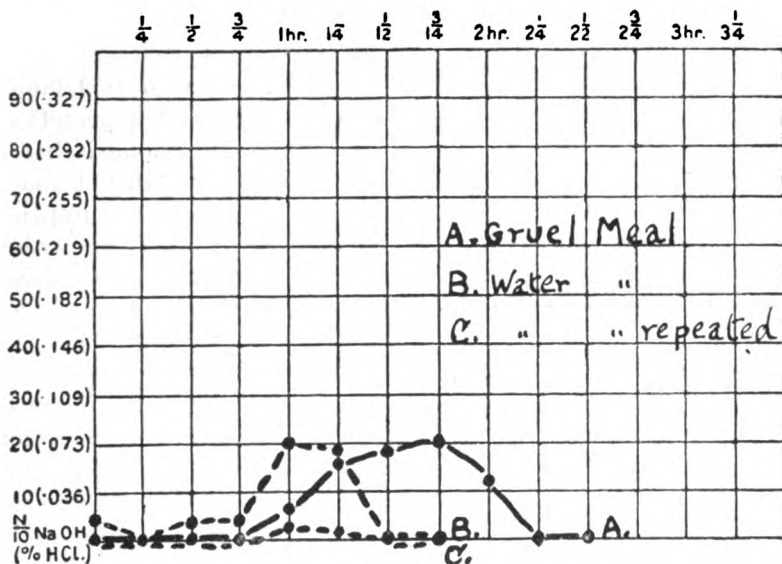


CHART I.

Comparison between the curves of gastric HCl in a normal subject—

(A) after a gruel-meal,

(B) after swallowing one pint of water,

(C) after swallowing one pint of water on a second occasion.

P.S.—Since writing the above, we have read A. C. Ivy's "Studies on Water Drinking" in the *American Journal of Physiology*, v. 420, 1917. All the results given above will be found in his work and we wish fully to acknowledge its priority.

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III. THE EFFECT OF ATROPINE AND OF PILOCARPINE ON THE SECRETION AND MOTILITY OF THE HUMAN STOMACH

By T. IZOD BENNETT, M.D., Assistant Physician to Middlesex Hospital.
(From the Physiological Department, Guy's Hospital.)

ATROPINE has in this country been seldom employed with the direct object of controlling gastric secretion. Our knowledge of the general effect of this drug in paralysing the ending of all cranial autonomic nerves should lead us to expect a powerful gastric effect; but so widely read an authority as Dixon¹ makes no mention of it, and Cushny,² beyond quoting Riegel, lays no emphasis on its action on the stomach.

German writers on gastric physiology and pathology pay more attention to atropine, but here again opinion is divided, Bergmann³ strongly recommending the drug for excessive secretion, whilst Schick⁴ employs it chiefly against pylorospasm. The general German view will be found summarised in Meyer and Gottlieb's *Pharmacology*,⁵ where alkali treatment is considered of far greater value than that based on the use of belladonna.

French authorities, on the other hand, have long spoken with far greater approval; Mathieu and Roux⁶ consider it almost the most useful drug at our disposal for cases of hypersecretion, and, basing their treatment on the work of Lieutier,⁷ give large doses hypodermically, though not to the extreme degree employed by Tabora,⁸ who administers as much as $\frac{1}{20}$ of a grain of atropine sulphate daily for several weeks.

Since the introduction of the fractional method of gastric analysis has been introduced, voluminous additions have been made to the American literature dealing with gastric functions, but little work has at present been published on the pharmacological side.

The most important is that of Crohn,⁹ who has published researches on human subjects, which show the transient effect of alkalis, and which even suggest that neutralisation may be followed by an actual stimulation of the gastric mucosa and the production of an acidity greater than the normal. Bastedo,¹⁰ writing as recently as January of this year, refers to much of Crohn's work, and, when discussing the effects of atropine appears to have misread some of the former writer's words; he summarises the position as follows—

- (1) in hyperacidity cases atropine has no useful effects in any dosage;
- (2) in continuous hypersecretion cases, it may check the secretion after the digestive period, but does this in maximum doses only;
- (3) in pylorospasm it may be useful, but in maximum doses only; and
- (4) in the usual doses it is wholly without effect on the secretory or motor functions of the stomach.

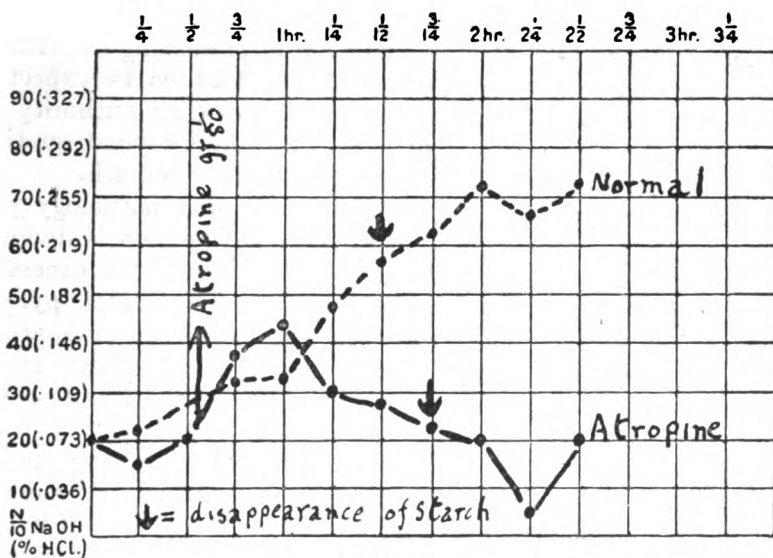


CHART I.

Effect of hypodermic injection of atropine (gr. $\frac{1}{50}$) in checking secretion of HCl. Broken line = curve of HCl normally; continuous line = curve of HCl in same subject after atropine.

Reference to Crohn's original paper does not wholly bear out these conclusions, and my own investigations lead me to believe that atropine is a far more useful drug than Bastedo implies.

In a number of medical students of the Physiological Department of Guy's Hospital I have, after determining their usual curve of gastric acidity, repeated the experiment and administered atropine either hypodermically or by mouth.

In every case where the drug has been given hypodermically there has been a very marked diminution in acidity. I have employed full doses, usually $\frac{1}{50}$ grain, as recommended by Mathieu and Roux, and chart I shows the striking nature of

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the change produced. This curve should be contrasted with chart II, which shows the transitory nature of the neutralisation obtained by alkalis; the dose given in the latter case was sodium citrate gr. 5, and magnesium hydroxide gr. 12.

A second series of experiments was made, in which, instead of employing hypodermic injections, the empty stomach was washed out with a weak solution of the drug. All resting-juice having been removed, $\frac{1}{80}$ grain of atropine sulphate in 60 c.cms. of water was introduced through the Einhorn tube; after one

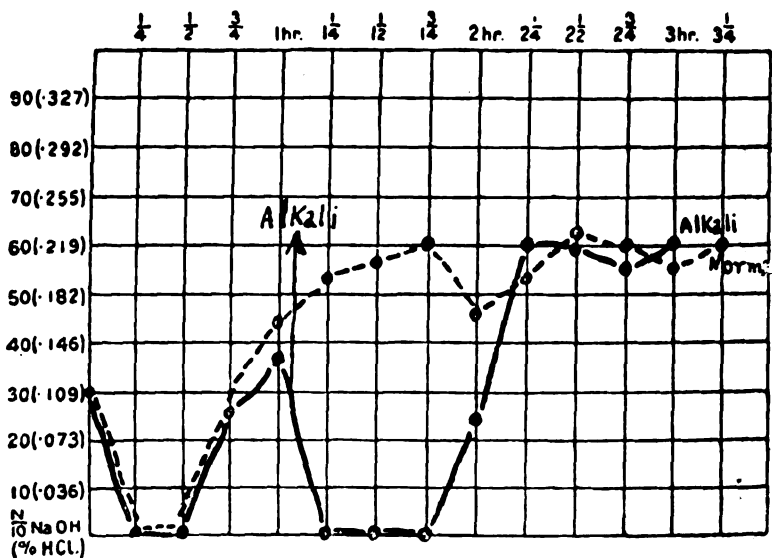


CHART II.

Transitory effect of alkali in neutralising gastric HCl. Broken line = curve of HCl normally; continuous line = curve of HCl in same subject when alkali was administered by mouth one hour after meal.

minute, during which the subject manipulated the anterior abdominal wall, all stomach contents were withdrawn and the gruel-meal was then swallowed.

In this series, of which chart III is one example, there was again a notable diminution of acidity; and when the smallness of the dose is considered, it becomes evident that atropine must be capable of strong local action when applied directly to the mucous surface of the stomach.

As regards the motility of the stomach all my experiments with atropine show a prolongation of the emptying-rate; this has never amounted to more than half an hour.

During the same period I have carried out a parallel series

of observations with pilocarpine; given hypodermically, I was unable to obtain any increase in acidity, though a diminution in the emptying-rate was almost constant; profuse salivation was so marked an accompaniment of the injection, that I believe it to be quite sufficient to account for the failure to produce increased acidity.

In the second series, where the drug was introduced into the empty stomach in dilute form and then withdrawn, a slight increase in acidity was occasionally observed, but the majority

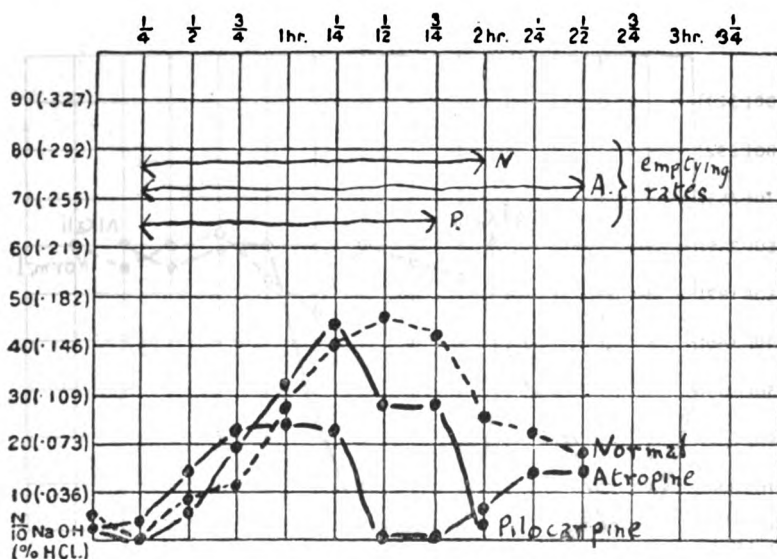


CHART III.

To illustrate effect on gastric secretion produced by washing the empty stomach with (a) atropine and (b) pilocarpine. Broken line = subject's normal curve of gastric HCl; continuous lines = curves of HCl in same subject after empty stomach had been washed out with a weak solution of (a) atropine and (b) pilocarpine.

of cases again showed little change beyond a slightly increased rapidity of emptying; an example of this effect is seen in chart III.

CONCLUSIONS

1. Atropine given hypodermically produces a notable diminution in gastric secretion when full doses are used.
2. The same drug, when given by the mouth on an empty stomach, shows a powerful local effect on the nerve-endings.
3. The diminution in acidity so produced lasts much longer than the neutralisation caused by usual doses of alkalis.

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4. Atropine in these doses slightly prolongs the emptying-rate of the stomach.

5. No marked increase in gastric acidity is produced by pilocarpine in usual doses, whether given orally or hypodermically; this is possibly due to the profuse salivation produced by the drug.

6. A diminution in the rate of gastric emptying is produced by pilocarpine.

7. No cardiac or respiratory changes were evident in the subjects of these experiments.

The writer wishes to express his appreciation of the help which he has received in this work from many students in the Physiological Department of Guy's Hospital.

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THE INFLUENCE OF NERVOUS UNREST ON DIGESTION IN INFANCY

By H. C. CAMERON, M.D., Physician in Charge of Children's Department,
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THE digestion of all infants is easily upset. A need for food, which, measured by adult standards, is relatively enormous, a low immunity against catarrhal infections of all sorts, and a highly unstable nervous system are three of the most characteristic features of infancy. Dyspepsia at that age may have a purely alimentary origin. It may be caused by an excess of food, overstepping even the high tolerance which the young child possesses, or, in artificial feeding, by an ill-constructed diet, containing an excess of some one constituent, as, for example, the fat or the sugar. Equally commonly dyspepsia is symptomatic of some infective process, either intestinal or non-intestinal. The young infant has but one prominent function—that of absorbing food, and in consequence disturbance of this function plays a leading part in the symptomatology of the most diverse disorders. In the third place the lack of nervous control, the violence of emotional display, the great activity of the sympathetic and visceromotor apparatus, with the large size of the suprarenal glands, all indicate the prominent part which disturbances of the nervous system play in the production of digestive disorders in infancy.

Of the literature which deals with the abnormalities of infantile digestion it is perhaps true to say that too little attention has been paid to these considerations. Scrutiny has been directed too exclusively to the composition of the diet. The assumption that dyspepsia is to be explained by an unwise, or at any rate an unsuccessful, choice of diet is not always correct. Even when it has been recognised that the origin of some particular disturbance lies in infection, it has been too often assumed that to be an adequate explanation the infection must involve the gastro-intestinal tract, that is to say, must take the form of a gastro-enteritis. The symptoms of nervous disturbance have commonly received even less consideration and have been set aside as invariably the result of the dyspepsia and in no way concerned in its causation. I believe that just

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as we meet with instances in which dyspepsia is clearly and without question due to faults in the diet, and with cases which are secondary to infection of parts remote from the bowel, so also we encounter cases in which the cause is to be found in the nervous and emotional unrest. The separation is of great practical importance, because it is in the first group alone that much can be achieved by therapeutic modification of the diet. That in many instances the symptoms are dependent upon a combination of these ætiological factors does not make it any the less important to bear in mind the part which each may and does habitually play. Often we may recognise in the dependence of each upon the others the working of a vicious circle. Thus infection lowers greatly the tolerance for food and causes dyspepsia, while dyspepsia of any duration is accompanied by a rapid fall in the immunity against infection. Again, dyspepsia is commonly accompanied by increased irritability of the nervous system, while at the same time nervous unrest interferes with effective digestion.

I propose in this paper to consider only the part played by nervous unrest in the production of infantile dyspepsia and to argue that there are many cases, not difficult to recognise, in which the dyspeptic symptoms are only to be controlled by measures directed towards quieting the nervous system, and in which change of diet or limitation of diet are without good effect.

The ill effect of nervous unrest is best studied in infants at the breast. Not that cases of dyspepsia due to nervous causes are not equally common in artificially fed children. It is, however, convenient to deal with infants naturally fed, because we may then exclude with greater confidence dyspepsia of alimentary origin, due to an unsuitable diet. In hospitals and in similar institutions it is true that few opportunities for the study of nervous unrest in infancy present themselves. Within a hospital we may have admirable facilities for the study of the diseases of children; we have, and can have, but little opportunity for the study of the child or the infant himself. In an institution the conduct of the nervous child is usually in sharp contrast to his conduct in the home. I do not doubt the influence of heredity, but experience forces the conclusion that the most important factor in the production of nervous unrest in the child is the contact with a mother who is timid, over-anxious or inexperienced, or who is herself suffering from some degree of nervous overstrain. The communication of nervous unrest from mother to child in this way is as subtle and as inevitable as that between a rider and his half-broken young horse. No baby will lie

quiet in the arms of a woman who is not herself calm. The infant, who in his own home is sleepless and emotional, dominating nurse or mother by his cry, when removed to an institution, with its quiet routine and with the interplay between the personalities of the attendants and the child reduced to a minimum, almost at once ceases to struggle and begins to sleep soundly and well.

THE SYMPTOMS OF NERVOUS DYSPEPSIA

Infants suffering from nervous dyspepsia as a rule are quick, observant and intelligent. The muscular tone is commonly increased. The abdominal wall is seldom distended, but tends to be retracted, with the lines of the recti muscles showing prominently. Often there is some degree of opisthotonos present owing to the increased tone of the muscles of the back. The head is held up at a surprisingly early age and the movements of the limbs are extraordinarily powerful. The strength and violence of the child's movements are nearly always commented on by the mother. The patellar and other tendon reflexes are usually brisk. The facial expression is constantly changing from that of interest to fretfulness or alarm. Sudden movements in the vicinity of the child, bright lights, and loud sounds are apt to cause a violent start. Especially sleep is disturbed, of short duration and of little depth. The child sleeps so lightly that with a sudden start it is awakened by the slightest stimulus. In the very moment of awaking the anxious expression flows back into the face and the loud crying begins. The slow return to consciousness and the gradual onset of crying of the normal baby are not seen. Hunger is a constant symptom. Sucking is violent, inco-ordinate and ineffective, and gives rise to a great deal of swallowing of air. Projectile and explosive vomiting is common. Diarrhoea, generally lenteric, is less frequently seen. Passionate, angry crying may persist for hours at a time, leaving the child pale and exhausted at its conclusion. The increment of weight is small or altogether absent.

In many ways these symptoms contrast with what we find both in dyspepsia from other causes and in true inanition or underfeeding. In dyspepsia from overfeeding and in dyspepsia as a symptom of infection the muscular tone is strikingly diminished. The child grows soft and flabby. The abdomen becomes distended from meteorism. The immunity falls and the skin in consequence is apt to show a variety of catarrhal disturbances—dermatitis, urticaria papulata, furunculosis and

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so forth. In true inanition, on the other hand, the infant is inactive and apathetic. The temperature is persistently sub-normal. Constipation with the so-called hunger stool, consisting mainly of pigmented mucus and débris from the bowel, as in the meconium passed in the first days of life, is an invariable symptom. The cry is weak or wailing; violent, emotional crying is seldom met with. Sleep may be but little interfered with.

THE INCREASED DEMAND FOR FOOD OF THE INFANT WITH NERVOUS UNREST

Of the energy derived from the food taken by the child a part may be regarded as devoted to maintaining the minimal or basal metabolism, *i. e.* the metabolism in complete muscular and gastro-intestinal rest, a part, calculated as about 10 per cent. of the whole, is lost in the excreta, while the remainder is divided between the expenditure upon growth and upon the muscular activity displayed in movement and crying. It is clear that the energy expended under this last head, that of muscular activity, is enormously increased by nervous unrest such as has been described above. We can attempt to estimate the increased loss from "insensible perspiration" during prolonged spells of crying, by accurate weighing. The variations in the weight of an infant during the twenty-four hours of the day and night are considerable. A variation of 100 grms. at one month old and of 200 grms. at six months old is commonly found. The weight is lowest in the morning before the first feed and highest in the evening after the last. This increase during the day is due to the excess of intake of food over the combined loss in the excreta and by insensible perspiration. The fall in weight in the night is due to the excess of the loss by excreta and insensible perspiration over the intake of food. If the napkin is not changed between two feeds, the loss of weight between one feed and the next will be a measure of the water lost from the skin and the lungs, the so-called insensible perspiration. In a series of estimations of this sort carried out upon breast-fed infants in the first month of life, who were sleeping well and spent the time accordingly comparatively motionless in an air-space of constant high temperature, the figures varied from 15 to 40 grms. On the other hand, with wakeful babies, who were crying violently and whose limbs and bodies were kept in constant movement through the air it was by no means unusual to find that the loss of weight in the three or four hour interval between meals amounted to 100 grms, in one case to

180 grms, an amount greater than the milk taken at the preceding meal. By means of a respiratory chamber Talbot¹ has shown that in normal infants by kicking and active muscular movements the metabolism was increased in one case by 20 per cent. and in another by 80 per cent. over the basal metabolism in the 24 hours. The morbid activity of nervous crying infants is probably productive of a much greater increase. Talbot and Benedict² have also shown that during crying the heat lost by young infants may be increased for short periods by as much as 200 per cent. Heubner and Rubner³ have estimated that the energy available for growth in the young infant is normally from 12 to 15 per cent. of the total food energy. It is clear from these figures that the total energy available for growth may be easily swallowed up by the increased expenditure upon muscular activity. The greater output of energy in the constant, restless movement increases correspondingly the demand for food, and this shows itself in hunger, which in turn adds to the unrest. Further, when, as is commonly the case, the symptoms of dyspepsia with vomiting and sometimes with diarrhoea are added, the loss by the excreta will greatly exceed the normal figure of approximately 10 per cent. It is therefore not surprising that the mothers of such children are invariably convinced that the explanation of the symptoms is to be found in a want of sufficient breast milk and as a rule demand that supplementary feeding should be instituted. In practice nervous unrest is perhaps the most common cause of failure to nurse. Supplementary feeding is begun, and with its institution the breast secretion further declines until weaning is complete.

THE EFFECT OF NERVOUS UNREST UPON SUCTION

Not only do restlessness and crying increase enormously the energy expenditure of the child and the demand for food, but at least in breast-fed infants it is apt to interfere seriously with the ability to suck, and if suction is faulty, the breast, insufficiently stimulated, will fail to satisfy the increased hunger. In young infants suction is rather a reflex than a voluntary act. A finger or any like object placed in a certain position on the dorsum of the tongue at once evokes powerful suction movements. The anencephalic monster is capable of effective suction, innervated from the medulla oblongata only. This reflex is commonly inhibited in two ways. It is inhibited in extreme somnolence, such as we commonly find in premature children and in some full-time infants who are peculiarly drowsy and lethargic. Suction in such cases may only be induced under the pressure

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of constant stimulation and rousing from sleep. On the other hand, suction may be completely inhibited by violent emotional disturbances on the part of the child. It is not uncommon to find infants who are crying violently, with tense, rigid muscles and opisthotonos, and who, when an attempt is made to nurse them, have as it were no attention to spare for the breast. With wide-open mouth they continue to cry. The sucking reflex is inhibited by the violence of their emotions. In other cases the crying ceases when the child is brought to the breast, and the nipple is grasped eagerly and hungrily. But instead of the rhythmical, effective, reflex suction of the normal young infant, we meet with eager, purposive attempts at suction, which, like all the voluntary movements, are inco-ordinate and uncontrolled. The milk is swallowed in great and hurried gulps, mixed with much air. Often percussion after a meal taken in this way will reveal the extent to which the stomach is distended with air. The escape of the air from the stomach is assisted by the device known to all nursing mothers of holding the baby upright. The air bubble in the fundus of the stomach is then brought more directly under the cardiac orifice and escapes more easily into the œsophagus. If, however, because of the child's position, the air in the fundus of the stomach is shut off from the œsophageal opening, it may only be expelled by so violent a contraction of the stomach that the whole contents are forcibly ejected—the meal recently taken as well as the offending air. The distension of the stomach is accompanied by clear signs of discomfort and often provokes a refusal to suck until it is relieved. Often too the peristalsis of the bowel seems to be excited directly by the taking of food. In the case of one such infant the bowels were open and a loose green stool was passed with the escape of much gas per anum on twenty-three successive occasions during the nursing attempt or immediately after it.

THE TREATMENT OF NERVOUS DYSPEPSIA

The treatment of the condition so described must be very different from that of dyspepsia due to excess of food or to unsuitable food. Especially it is clear that temporary deprivation of food or the limitation of food and the use of purgatives tend only to make the condition worse. It is essential that the needs for food of these children should be fully met if quiet and rest is to be secured. To increase the amount of food to cover the high demand is to run a great risk of overstepping the digestive capacity. The only effective treatment is to reduce

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the demand by securing rest and sleep by all the means available.

In the attempt to secure sleep it goes without saying that the personality of the attendant is of the first importance. Often enough sleep and freedom from dyspepsia come at once when the quiet, confident handling of a good nurse succeeds to fussy and too stimulating management.

Handling of the infant should be reduced to a minimum. It is a good plan always to carry such a child upon a pillow, an insulator which is especially necessary if the mother is overwrought and in a state of nervous tension as the result of the child's distressing crying. It is important to arrange for a constant high temperature in the air space in which the child lies and to provide against the entry of cold air as a result of the restless movements. Hot baths of long duration and kept at a constant temperature are helpful in producing sleep in states of excitement whatever the age may be. To assist in producing the quiet necessary for effective suction, one-grain doses of chloral hydrate and bromide may be given twenty minutes before feeding. To prevent aërophagy during suction it is further important to pay attention to the position of mother and child. The infant on the pillow should be placed on the mother's knees, while her body is bent forward to such an acute angle that the breast falls freely towards its mouth, with the nipple in the most dependent position possible. The infant should not be held up against the breast while its whole body is hitched in this direction or that in the attempt to assist it to get a better hold.

By such devices sleep can almost always be secured. As soon as sleep of good depth and duration is established, dyspeptic symptoms are relieved, suction becomes co-ordinate and effective, the breast is stimulated to greater secretion and there is a rapid gain in weight.

CONCLUSIONS

(1) Nervous unrest and excessive emotional display in infants, as in adults, are a frequent cause of dyspepsia.

(2) The energy expended upon crying and muscular movement is obtained at the expense of the energy normally devoted to growth.

(3) The increased expenditure upon crying and muscular movement may raise the need for food beyond the secretory capacity of the mother's breast.

(4) The suction power of the child declines, because

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the emotional excitement renders the suction inco-ordinate. Faulty suction leads to a diminished yield of breast milk.

(5) "Wind" is the result of aërophagy and is a constant accompaniment of too eager and ill-controlled suction in infants with nervous unrest.

(6) Measures directed towards securing sleep are alone effective in controlling nervous dyspepsia.

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THE NEW PSYCHIATRY :

Some Impressions of the Work of the PHIPPS PSYCHIATRIC CLINIC, JOHNS HOPKINS HOSPITAL, BALTIMORE.

By C. P. SYMONDS, M.D., Assistant Physician for Nervous Diseases,
Guy's Hospital.

At the present time the problems of psychology, normal and abnormal, are beginning to attract considerable attention in this country, largely owing to the experiences of the war, which compelled both physicians and laymen to realise the frequent occurrence of functional nervous disease and the necessity for its treatment on scientific lines. The responsibility of psychogenic factors in the development of war neuroses was as a rule very evident. The conflict between the emotional forces of self-preservation on the one hand and self-esteem and loyalty on the other, occurring as it did in thousands of healthy adults of average make-up, provided a comparatively clean-cut psychological experiment, the results of which were easily studied.

In civil life it is generally admitted by physicians that functional nervous disease is as common as in war, but in this less crude setting, where the instinct of self-preservation does not play so predominant a part, the psychogenic factors are by no means so easily discovered.

The Phipps Psychiatric Clinic, comprising eighty beds for in-patients and an out-patient department at work five days in the week, was founded in 1912 for the study and treatment of early cases of mental disease, and under the guidance of Professor Adolf Meyer and his assistant, Dr. Macfie Campbell, much valuable work has been done in the detailed investigations of the causal factors underlying the psychoneuroses and the psychoses. It was the privilege of the writer to spend several months as a resident in the Clinic and to see for himself the methods employed.

Since the teaching of the Phipps Clinic represents in part a reaction from Kraepelinian doctrines, it will be well to give a brief account of these. Kraepelin, in the latter part of the last century, set out to apply modern scientific methods to the study of mental diseases, a field hitherto little explored.

Mental diseases, he presumed, were as much specific entities as diseases of the lungs or liver, and he made it his aim to classify them in terms of (1) etiology, (2) pathological anatomy, (3) symptomatology and (4) prognosis. Those disturbances of the mental processes in relation to which a definite pathological picture can be found, for instance, general paralysis of the insane, and cerebral arteriosclerosis, were already firmly established on such a basis; Kraepelin set before him the task of investigating with similar aims the much larger group of disorders of which little was known. His observations were accurate, and his results most carefully analysed, but his field of research became limited to the two last of the four categories—symptomatology and prognosis. He found, as others before him had found, no distinctive pictures in the brain examined by the naked eye or under the microscope, which he could correlate with the groups of symptoms—this field was barren. Nor were investigations in the realm of etiology much more fruitful: a comparatively small number of the psychoses could be definitely associated with infectious fevers or poisons such as alcohol, but the majority could be assigned to no such causes.

He achieved, however, a most exhaustive analysis of the symptoms manifested by the patients under his observation, and by following up his cases was able to correlate these symptoms with the prognosis. Thus arose his classification of the psychoses. Kraepelin found that patients showing a certain group of symptoms, negativism, stereotypy, echopraxia and so on, showed a tendency to progressive deterioration without recovery and labelled this group *Dementia Præcox*. He found another group of cases which were liable to recurrent attacks of excitement and depression, but always tended to get well, and to these he gave the title *Manic Depressive Insanity*, the classification again being made on a purely symptomatic basis.

Kraepelin's work was undoubtedly of great value and his classifications still hold the field, but modern psychiatry has advanced farther. The reason *why* any individual showed a particular symptom Kraepelin did not inquire: this was for him part of the unsolved problem of the etiology, a manifestation of the mental disease process. Dr. Campbell of the Phipps Clinic tells how when he was at Kraepelin's clinic during a ward round, at the great psychiatrist's request, one of the students, a Japanese, attempted to shake hands with a new patient. The patient promptly withdrew his hand with a muttered "Damned heathen!" "Ach!" said Kraepelin, "Negativismus!—dementia præcox!" There, in the facts underlying the conduct of this patient, lay a simple

problem of behaviour, which Kraepelin, wrapped up as he was in a strictly objective estimation of symptoms, failed to see.

At the Phipps Clinic, while use is made of Kraepelin's work and due recognition made of the need for research along his lines, it is just these problems of behaviour ignored by him, which receive most attention.

Why does this person begin to show restlessness and depression, and this other to complain that people are conspiring against him? Will not inquiry into the antecedents of the patient and the circumstances leading up to these peculiar disturbances of behaviour perhaps throw light upon the problems? Every human life, as Dr. Meyer sees it, is in its broadest sense an experiment of nature. Individuals from the outset are variously equipped: one may be born with a poor resistance to tuberculous infection, another may inherit the alcoholic habit, and yet a third may start life with a predisposition to react in a peculiar way to certain problems in relation to the development of his instinctive life. For the causes which lie behind these varieties in the inheritance we are still groping somewhat in the dark. But we have learned that explanations of temperamental peculiarities are not to be sought merely in anatomical studies of the brain: that a phlegmatic disposition may depend on lack of pituitary activity and excitability on hyperthyroidism: and it is to the biochemist rather than the morbid anatomist that we look for further light in this field.

On the other side, we have unlimited variations in the environment: the man with a tuberculous diathesis, if he but have the means, may live in the mountains of Switzerland to a ripe old age, while his more healthy but less fortunate brethren fall by the wayside in the germ-laden air of the city. The potential dipsomaniac, if he be born west of the Atlantic, may lead a useful and sober life, while on the other side of the water a man with no such dire inheritance but unlimited supply of bad whisky drinks himself into an early grave. An individual with a tendency to morbid ruminations over sex difficulties may, if his path be made smooth by sympathy and frank enlightenment, steer a comparatively straight course through life, while others less fortunate in their circumstances go hopelessly astray.

Therefore, in the analysis of every problem of behaviour there are two groups of factors to be considered—the personal and the environmental—two questions to ask ourselves: “What stuff is this man made of?” and, “What is the situa-

tion he has had to face?" So we go back to the beginning and inquire of his inheritance, then of the manner of his upbringing and how he reacted to it, whether he was shy or open as a child, seclusive or a good mixer. Later there are problems common to all, crises in the lives of many. How did our patient react to the development of the sexual impulse, with all its train of conflict between the instinctive forces of the individual life, and those laws of right and wrong, which are recognised no less instinctively by every member of the herd that lives by them? How did he meet the need when the time came to make a path in life for himself? With what thought did he take upon himself the responsibilities of marriage and parenthood? Have there been serious problems peculiar to his own life which he has never faced squarely nor overcome?

Thus we obtain a certain measure of the personality of our patient, then turn to the circumstances of his life at the time when he began to fall ill and seek the things that really mattered to him at that time. In such a manner we are eventually able to sum up the case in terms of the reaction of a particular individual to a particular situation, and we classify our cases, not under the Kraepelinian headings, but according to the type of reaction observed.

Why, then, did a certain John Smith in the month of June 1920 begin to mope alone, complain to his wife that his fellow-workers were conspiring to do him injustice, that lights in the house opposite were signs for the guidance of his life, and that people came up behind him when he was at work and accused him of stealing? Why, whenever he saw two people talking together at a street corner, was he sure they were talking about him? Certainly they led him to behave in a queer manner, these ideas of his. He would not go out of the house, nor even allow his wife to do so, and she brought him up to the hospital only with the aid of his parents, against his will. He himself said that he had had the influenza and a bit of a nervous breakdown after it—that was all.

Now for the personality. The main facts in the inheritance were that he proved to be an adopted child, being in reality the son of a drunken prostitute by an unknown father. And his intelligence was much below normal, his mental age on the Binet-Simon scale giving him an intelligence quotient of 75. So above the mentally defective line. He himself was very intelligent, however, but the facts of his situation leading to his illness being gradually pieced together revealed this state.

Some there was in seven years, and he was more than twice—he

had earned a wage which was a fair measure of the level of his intelligence; his work was to clean an engine in a power-house. His trouble began when he married a wife with extravagant notions: she found his wages all too little and raised loans on the furniture. Then she began to upbraid him for not earning more. He left his old job for a month to try another, the lowest kind of skilled work. At this he failed miserably and returned to his cleaning. Things at home, however, were growing desperate and he took to brooding over them: if only he could get money: even stealing. . . . And then there seemed a chance: there was a vacancy for a man to operate a machine at a much higher wage than his; he had been fourteen years in the shops, why shouldn't he get it? Of course, he did not get it. If he had had the ability or the courage to face things frankly, he would have seen that he would not get it because he simply had not enough brains, and his employers knew it. The trouble was that he would not face the thing frankly. And this was the beginning of the foisting of all his troubles upon the outside world. He would not face the real reason for his failure, he must then have an alternative. "My mates are all against me," he said to himself, "the whole Union is joined against me." He developed the habit of always putting the blame upon others. Did he have ideas of stealing, he complained that people accused him of being a thief. The words of his own self-reproach were put into the mouths of those whom he felt were saying bad things about him at the street corners. He became so accustomed to offering to himself and accepting these false explanations, that when at last he could not sleep at night but paced about the room, he complained to his wife that it was the fault of the bed, that it would keep moving about.

The story of John Smith is not fiction but fact. He did indeed come up to the out-patient department of the Phipps Clinic in the month aforesaid, and in due time was admitted to the hospital. There, by slow degrees, he was brought to a frank realisation of his problems and the way to solve them. Moreover, his wife was made to realise exactly the part she had played in the causation of her man's breakdown, and urged to keep before her the fact that his limited capacity for wage-earning must be the measure of her expenditure. Finally, the Social Service worker of the clinic visited Mrs. Smith and was able to ease the domestic situation a little by patching up a quarrel between her and her "in-laws." And, under the guidance of the Social Service workers, John Smith when I last heard of him was back at work. How long he will remain

so I do not know. He has an easy way with him still of ascribing all the ills of his little world to outside interference: and a man who, when he cannot sleep, complains that it is his bed that is jumping about, has gone pretty far on the path of self-deception that leads to deterioration. But for the time being John Smith is well again and earning a living.

This is quite a typical instance of the kind of work aimed at and achieved at the Phipps.

I will give one more case. When I first saw Mary W. she was lying on a bench in the out-patient room, where she had just vomited: she looked pale and emaciated, her eyes were closed and her mother sat by her stroking her hand. Her age proved to be twenty-three, and the history obtained was that she had been ill for nearly ten years with "stomach trouble," which had become worse during the past six weeks; she had attended nearly every out-patient department in the hospital, and had had test meals, bismuth meals, X-rays of her chest, gynæcological examination, blood counts—every kind of investigation, with negative results in each case. And she had become progressively worse so that for the past three weeks she had been vomiting "everything she took."

She was taken into the hospital, and it proved quite easy to persuade her, after a little preliminary explanation of the gastric mechanism, to eat a full meal and retain it: after which she took ordinary diet and began to gain in weight. This, however, was only the beginning of the treatment of the case from our point of view. The problem before us was to discover the factors which caused this girl of twenty-three, in whom we could discover no lesion of any particular system, to become a complete invalid, and if possible remove them.

It took a little time to gain the confidence of the patient, and one or two interviews with her mother were necessary before we arrived at the complete story, which was as follows:

The patient was the only child of a mother endowed with more affection than common sense, who constantly spoiled her. She was always considered a nervous child, suffered from night terrors, and when thwarted would exhibit temper tantrums which often gained her point.

When she was thirteen years old her parents, who had been comfortably off, met with financial losses which compelled them to move to a poor neighbourhood where they found the society of their neighbours un congenial. Her mother took the situation hardly. Mary was not encouraged to mix with other children, she began to mope and would not go to school because felt she was shabbily dressed. And her mother sympathised.

Then Mary began to suffer with dyspepsia. Her mother in alarm took her to a doctor who found her teeth were in a bad way and had them all extracted. And now Mary felt herself in a worse plight than ever; she was inferior to those around her; her personal appearance was ruined. She would not wear the false teeth that were bought for her, had more dyspepsia, developed pains in the back and would hardly go out. And so she stayed at home and was fussed over by her mother.

At the age of seventeen apparently she became tired of this existence, and learned stenography, finally obtaining a post at which she worked four hours a day complaining all the time that this was too hard for her. She gave it up after a few months on account of pains in her back and stayed at home again. Six months later, on attempting to renew her work, she found that her indigestion prevented her from attaining the necessary speed at shorthand, and finally gave it up altogether.

Two months before her admission to the Clinic her father, the bread-winner of the family, became ill, and this produced an alteration in the domestic situation. Her mother had to nurse her husband and also go out to work. She began to find the matter of her daughter's health somewhat urgent. She took her to the hospital from one department to another: they all said there was nothing wrong. She tried coaxing, persuasion, bullying, but it was too late: the more she urged the more ill Mary became, until for the three weeks before she came to the Phipps she had vomited every meal. At this stage the more her mother attempted to force her to meet the hard fact of life and the necessity to go out and make a living for herself, the farther she drove her back into the illness which had for so long been her refuge.

So after all when all the facts were before us, the picture of Mary W. as I first saw her lying on the bench in the outpatient room, represented not the reaction of a stomach to food, but of an individual to a situation. Always having obtained her own way as a child, never having become emancipated from her mother, without self-confidence—each time she put out into the world she met with reverses. These were unpleasant. She might have gone on and overcome them, but instead she took the easier way of avoiding them by attributing all her incapacity to bodily ailments, which by force of suggestion grew more real in proportion to her need for greater protection.

It is important to realise that conscious malingering took no part in this process. Her behaviour represented the

imperfect reaction to a situation of ordinary difficulty of an ill-trained, undeveloped personality.

After she had had a month in hospital the confidence of the patient and her mother was completely gained, and the true interpretation of the illness was put to both of them plainly, and accepted on a common-sense basis. It was pointed out to the mother that the girl's one chance to maintain her health and improved attitude towards life was to leave home, and that it would be a sound investment on the mother's part to provide her daughter with the necessary means to make a start.

It had been discovered that the patient had strong religious trends, and gained a good deal of emotional satisfaction along these lines. After leaving the hospital she came into contact, through the Social Service workers at the Phipps, with an organisation for social work in connection with one of the churches. And when I last saw her a week ago she was asking my advice as to the wisdom of her becoming a lay worker in the church. She was then looking a different person, had gained sixteen pounds in weight, was smartly dressed and had a general air of self-respect—the very antithesis of herself as I first saw her.

There seems no reason why she should not continue to play a happy and successful part in the life of the world, though after so long an experience of invalidism as a refuge, it is possible that she might fall back into it if confronted with any especially difficult situations in the future.

This may sound a very ordinary story. But there are many Marys in the world who need help in straightening out life problems and are instead getting Mist. Gent. et Sodæ for their stomachs.

Dr. Meyer is insistent upon the futility of assuming fundamental differences between the practices of psychiatry and general medicine; between sickness of mind and sickness of body. It should be the practice of general physician and psychiatrist both, to consider the patient not merely as a collection of organs, but as a human being, a unit in the social system.

Every patient admitted to the Phipps Clinic is subjected to a physical examination as thorough as that carried out in the general medical wards; and in the summing up of the case due attention is paid to the physical findings.

If the patient is suffering from pyorrhœa alveolaris, intestinal stasis, or psoriasis, these are causal factors in the impairment of his functional efficiency and need attention.

One cannot help feeling that in the general wards of a

hospital, on the other hand, too little attention is paid to the psychogenic factors in disease, that is to say, to the sources of impairment of the functional efficiency of the patient, which depend not on demonstrable reaction of a particular organ or system to disease, but upon the reaction of the whole individual to a situation in which his organic disease plays some part. As an instance, let us take the difference in duration of convalescence from a head injury between a worker who is receiving compensation and one who is not, a difference which depends very often upon the fact that the latter has the force of the bread-winner's instinct to drive him forward.

A guiding principle of in-patient work at the Phipps is that the interests of the individual shall receive first consideration. Therefore, the question of insanity, which is a purely legal diagnosis arising out of the demands of society for protection, is put aside until a decision is called for as to the ultimate disposal of the patient. Patients are encouraged to consider themselves as persons requiring a physician's help in straightening out difficulties in their lives. And to support this attitude every patient is admitted on a voluntary basis, and signs a declaration of his willingness to come into hospital. Nor is any case admitted on a certificate of insanity, whether willing to come in or not.

This attitude is maintained in the relations of nurses and orderlies towards the patients, with the not infrequent result that a patient who has at first been coaxed into entry by her family and begins by being sullen and uncommunicative, will after a few days throw aside the barrier of her reserve, and herself bring her troubles to the nurse or physician.

The building itself is a fine piece of architecture, comprising three sides of a square with a garden enclosed, in which a bubbling spring feeds a miniature stream and pool. Within, it is spacious, and there is a comfortably furnished living-room attached to every ward. For regular occupation there are classes in carpentry and basket-making; there are daily ball games in the hospital campus for the men, and occupying almost the whole of the top floor is a fine recreation-room where there is music and dancing.

There are bars on all the windows, but skilfully disposed to avoid any dungeon effect. The one thing resented by most patients is that the ward doors are kept locked, but this is found essential.

One-half of the basement is given to the out-patient department, which is open every morning. Here are six small rooms in each of which a physician sees patients privately, working

up his cases as fully as possible and generally giving an hour to each. Dr. Campbell makes rounds of these rooms, seeing each case when the notes are ready for presentation to him. Here patients showing obvious deterioration are frequently certified insane and sent to state hospitals: mild cases receive help and advice, and come up from time to time. Others are admitted for diagnosis and treatment.

A good deal of work here is done with children, brought up on account of nervousness or backwardness, and much use is made of the revised method of estimating intelligence by the Binet-Simon method. Not infrequently it is found that it is one of the parents that needs treatment, not the child!

Finally, a very important part is played in the work of the Clinic by the Social Service workers. These are two ladies in the salaried employ of the hospital, whose whole service is devoted to the Clinic. It is their function, as it were, to project the Clinic into the domestic life of the community. There frequently arise important questions in connection with the diagnosis of patients, which cannot be settled without their aid, especially in relation to children, where one has to discover, for instance, in a case of mental retardation, how much is due to the defect in the child, how much to faults in school or home environment.

Miss Lyons and her assistant, Miss Webb, undertake such and many other investigations. They have a room on the out-patient floor, and a physician may refer a case to them for a report, which in the course of a few days is made, typed and filed, to be presented with the case notes at the next visit of the patient.

In the treatment of out-patients they play an even more important part. They make it their business to be in touch with all employment agencies, charitable organisations, church institutions, heads of primary schools and so on. And working always in co-operation with the physician they are often able to put into practical effect the recommendations which he makes. Through their agency also it is possible for the physician to keep in touch with his old cases. He has only to inform the Social Service worker that he wishes to see a particular patient in six months' time, and may depend upon it that the patient will receive a reminder, and if necessary will be brought up at that time.

Such in brief outline is the work of the Phipps Clinic. In a paper of this length I cannot give my readers an insight into the fascination of the problems presented by this branch of medicine, which is only to be obtained by personal observation

of analysis in detail. As a beginner, entirely without preconceived notions, I was most impressed by the frank response of most patients to questions affecting the most intimate details of their lives, and the genuine relief shown by many of them at being able to discuss problems in relation to sex-life without restraint—from a biological rather than a sociological standpoint. The physician cannot shut his eyes to the fact that the sex-instinct is one of the potent driving forces in a man's life, that its direction along the channels prescribed by social needs and modern standards is a problem seldom solved without mental conflict, and that such a conflict waged in the dark often leads to depression, feelings of inefficiency and even upheavals of a more serious nature. I do not wish to subscribe to the doctrines of Freud, but I am convinced that in the investigation of mental disorders it is as important to inquire into the problems of sex-life, as it is to examine the heart and lungs in every case of systemic disease.

If the success of a clinic of this kind may be measured by its popularity, the Phipps may be deemed successful. The out-patient department is always busy, and the waiting list for admission is out of proportion to the number of beds available. It would seem, then, that the Clinic meets a real need in the life of the community.

THE QUANTITATIVE ESTIMATION OF THE VIBRATION SENSATION

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INTRODUCTION

THE present studies were undertaken at the suggestion of Dr. A. F. Hurst in continuation of those of J. L. M. Symns.¹ Working at Guy's Hospital in 1911, Symns was the first to essay the quantitative measurement of sensibility to vibration. He ascertained the period during which the vibrations of a heavy tuning-fork, starting at known rate and amplitude, continued to be felt on certain bony points. In his experiments he used a fork $18\frac{1}{2}$ inches long with vibration amplitude of approximately 1 mm. and rate 108.75 double vibrations per second, by means of which he was able to establish the duration of appreciation in normal individuals and its variations in certain diseases of the nervous system. It was felt, however, that the graph representing the normals in his report was based on an insufficient number of cases (30), and the present paper begins with the results of a further research upon 100 cases carefully selected with a view to the exclusion of all functional and organic nervous conditions.

THE VIBRATION SENSATION IN NORMAL INDIVIDUALS

Bed-patients not seriously ill were found to be the most suitable subjects for investigation. A certain degree of intelligence was required, but not as high a degree as one would naturally have expected. It was essential to secure the patient's co-operation and to impress on him the importance of his concentration. Unless he kept his mind fixed on the procedure the termination of the appreciation of vibration was inaccurately indicated. It was surprising how easily this difficulty was surmounted. Many repetitions of the test on the same individual at varying intervals indicated the accuracy with which the replies were made. The cases rejected for the normal observation were patients taking opiates, or suffering from uræmia,

cardio-vascular disease associated with dyspnoea, and, as above mentioned, neurological cases, as well as those who for one reason or another would not co-operate.

It was notable that children gave very satisfactory replies, and often seemed better able to focus their attention on the subject than adults. In this series there were sixteen children ranging from six to fourteen years. The characteristics of the normal graph of Symns, as well as the normal graph of this series, differed markedly from that made from these sixteen children, which is especially notable in lacking the "sacral notch" so distinctive in adults.

Every effort was made to plan the present work on the exact lines laid down by Symns. A tuning-fork manufactured by Messrs. Down Bros., Ltd., was used (Fig. 1), and through their courtesy a number of forks of the same sort were compared not only in the normal cases, but also in those with definite organic nervous disease.

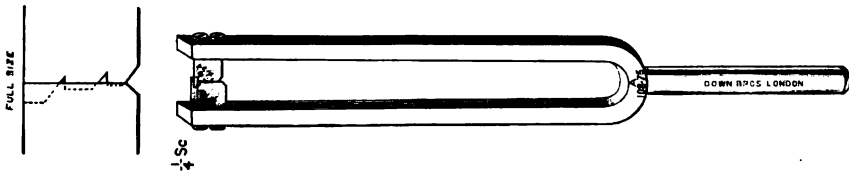
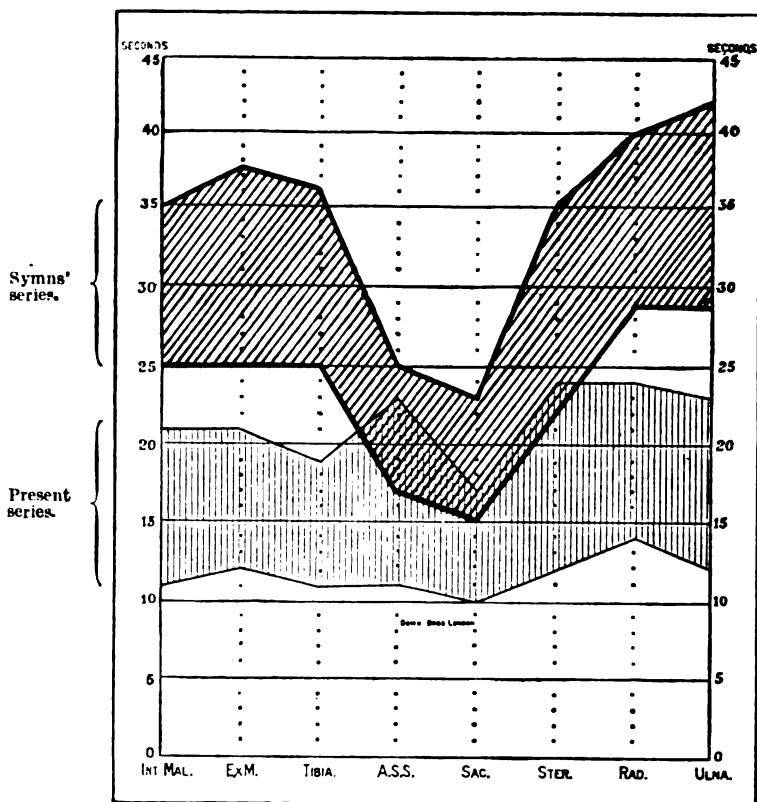


FIG. 1.

Tuning-fork for testing vibratory sensation.

Graph 2, which was made after the study of the first thirty normal adults, shows a difference, which is probably due to the fact that some of the hundred in Graph 1 were children. At first it was very discouraging to note the marked difference in these two series of observations, and it seemed reasonable to infer that a method subject to such variation could never become of practical value. The difference, however, was soon explained. With the assistance of Mr. H. G. Drew, of Messrs. Down Bros., Ltd., it was found that a number of different forks of the same vibration rate (108.75 double vibrations per second) and with the same type of window gave markedly different results. As Mr. Drew explained, this source of difference was due to a number of causes, the chief of which was variation in weight and temper of the shaft, a vibration of 2 mm. swing at the fork end being differently transmitted at the handle end if the rigidity of the fork varies. The instrument used in making the normal graph represented by the fine lines in Graph 1 is now regarded as the standard. It has been carefully weighed and measured; the window in this instrument has two slots, which

have been carefully registered, and every precaution will be taken to ensure the manufacture in the future of instruments conforming as nearly as possible to this standard, though it must be clearly understood that a hand-wrought instrument can never be exactly duplicated, and it is also not possible to reproduce temper accurately. In order to standardise later work a normal



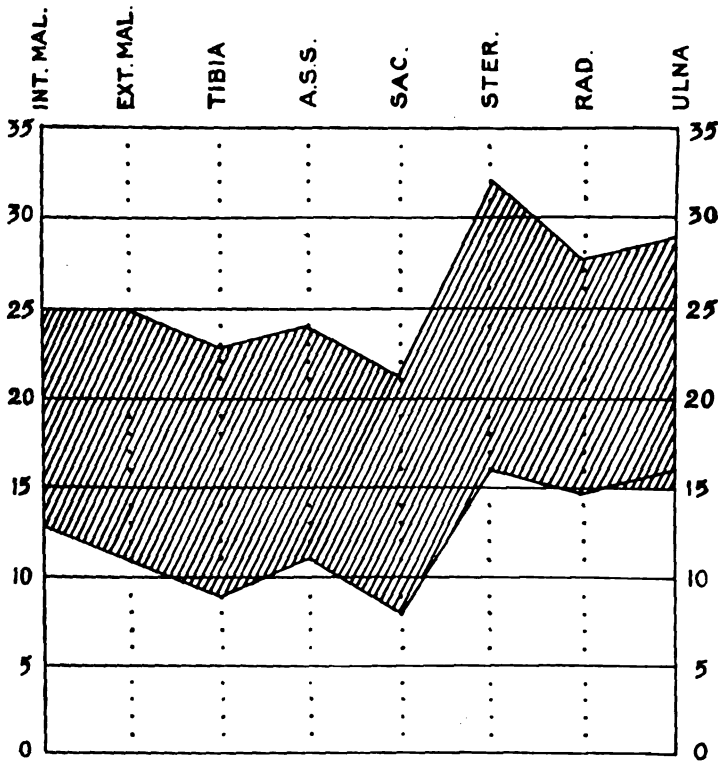
GRAPH 1.

Represents the normal of Symns compared with the normal of the present series, which was arrived at from the study of one hundred normals, omitting the highest ten and the lowest ten.

individual at Messrs. Down Bros., Ltd., has been selected, and on him daily observations were overlaid. The result of this is represented in Graph 4. In the future every instrument will be checked on this individual by a single observer, who has been taught to follow the plan adopted in the present work. Each instrument will be provided with a copy of the normal graph, on which will be superposed a line obtained with it from the "standard individual," so that the degree of so-called error can be clearly set forth. An effort is being

made by Messrs. Down Bros., Ltd., to make all the forks exactly alike, and there is some hope that this may prove successful.

Before beginning an observation the subject is explained in simple language to the patient. The metal handle of the vibrator is then applied to the skin surface over a bony point and the patient made familiar with the sensation produced. The instrument is then made to vibrate and applied as before,



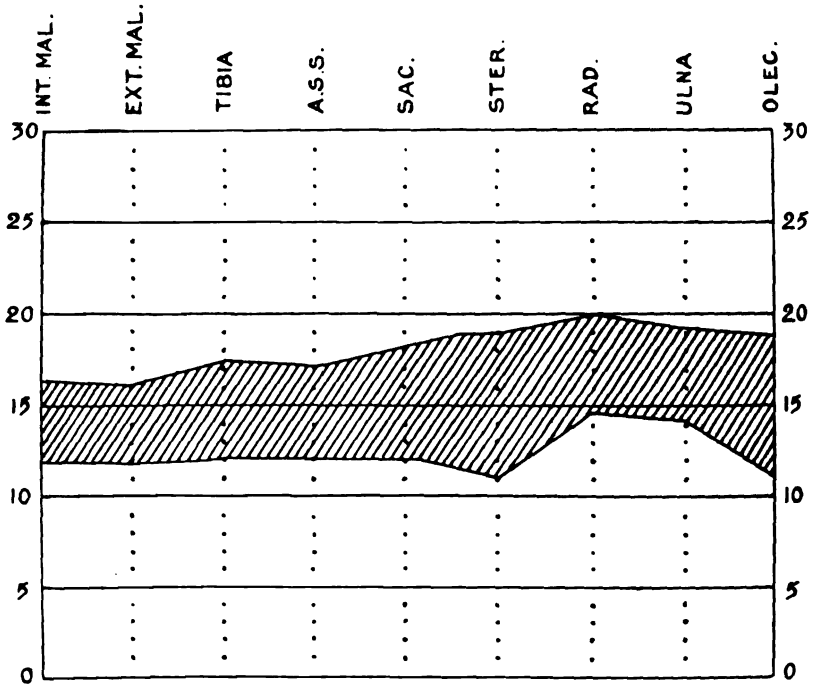
GRAPH 2.

The first thirty cases.

after which the patient is asked to express his idea of the difference in sensation. He is then impressed with the importance of riveting his attention on the vibration, which, it is explained, will gradually decrease in intensity. He is told that whenever in doubt about the time of the disappearance of the sensation he is to say so frankly, in order that the test can be repeated. In many instances a number of observations were made over the same point before a conclusion was reached.

For the successful operation of the test daylight is essential. The vibrating fork must be held between the observer and the

window. At the instant when the last beam of light is no longer detected through the window the handle of the instrument is applied to the bony point. With a little practice it becomes a very simple matter to localise the bony point with forefinger of the left hand, hold the vibrating fork to the light with the right hand and keep in view a watch with a large second hand which can be easily read in seconds. Symns used a stop-watch, and part of these observations were made in the same way with the help of Mr. Maurice Shaw. It was found



GRAPH 3.

Shows the results obtained in sixteen children.

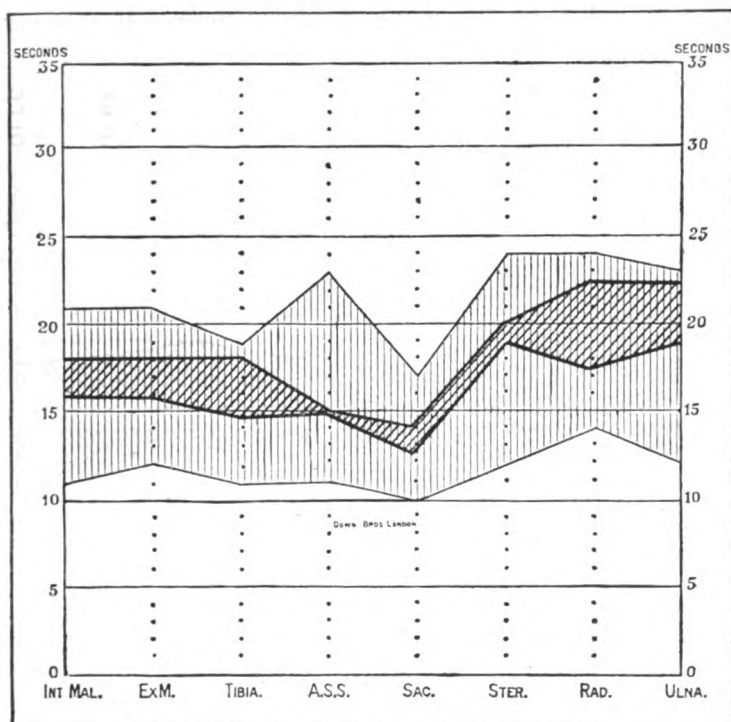
that the results were no more accurate with it than without it, and that the stop-watch to be accurately used required an assistant.

Experience soon teaches the amount of violence needed to start the vibrator. Much time is wasted by striking the fork so violently that it becomes necessary to wait many seconds until the window ceases to show light. Never will such skill be acquired that it becomes possible for the observer to ignore the help of the window.

The manner of application of the vibrator to the skin surface is a point of some importance. The best results followed when the instrument was held much in the same position as a

pen and applied at an angle covering as much of the bony area as possible. This was found much better than the plan of holding the fork in the fist and applying it vertically to the part with only the rounded end touching the skin.

The instrument has two slots in the window, differing in depth by 1 mm., and in the particular fork on which this report is based ten seconds elapsed between the disappearance



GRAPH 4.

Shadow represents range of normal in one hundred cases studied at Guy's Hospital. The heavily shaded area = several observations in a normal intelligent adult.

of the first and second windows. This was found useful in certain organic conditions, in which the vibration response was greatly impaired. When no response resulted with the smaller window the amplitude of the vibrations was increased by using the larger window. The normal graph, however, is based on results obtained with the smaller window alone.

With the information sent out by the manufacturer with the instrument comparable results will be obtained, and it is to be hoped that evidence confirming or correcting this work as well as that of Symns will soon be forthcoming. It is

obvious, as Dr. Hurst has insisted on from the first, that no progress can be made in the study of vibration sensation until it is put on a quantitative rather than a qualitative basis. It will be shown later that much valuable information is lost when a qualitative consideration of the vibratory sensation is alone used.

THE VIBRATION SENSATION IN PATHOLOGIC STATES

It was shown by Symms that the quantitative study of multiple peripheral neuritis by the vibrator was of great help in diagnosis. He found that in such cases the response over the sacrum remained normal, but a diminution in the vibration sense was invariably found over the bony points of the part or parts affected. As the vibration response over the sacrum in tabes is always diminished, if not entirely absent, the value of this test in differentiating the two conditions will be readily appreciated. In one case studied in the present work there was the scar of a deep transverse wound across the lower portion of the forearm. Just above this point the vibration response was normal, but below the vibration sensation was entirely lost.

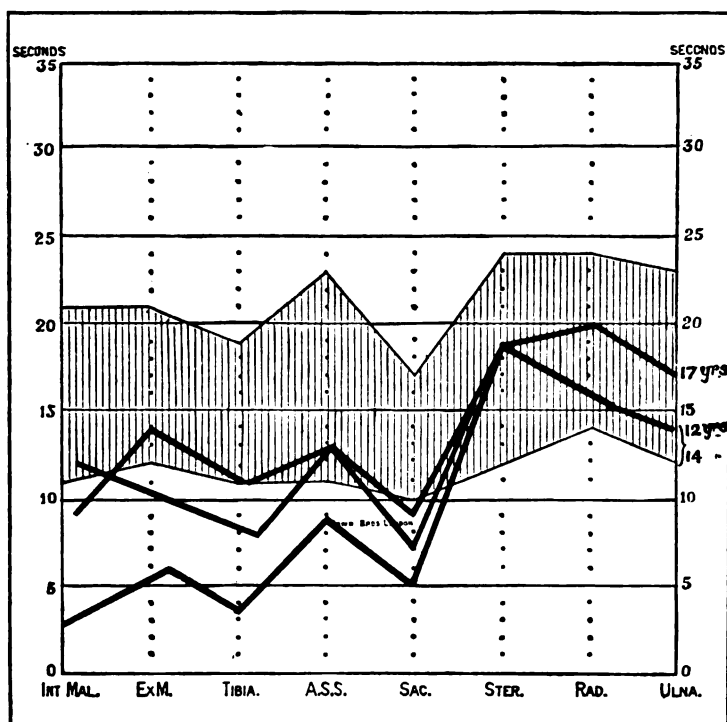
In disseminated sclerosis a number of cases were carefully observed. It was found that the vibration sensation was rarely much affected, and no characteristic variation from the normal was found.

In three cases of Friedreich's ataxia there was a diminution in the lower extremities and over the sacrum, as is shown in Graph 5. These three cases were brothers aged twelve, fourteen, and seventeen years respectively. It was a question, however, whether the diagnosis should not have been familial juvenile tabes, as evidence of congenital syphilis was present in all three boys.

The most important part of the work was that dealing with the vibration sense in tabes. Graph 6 was made from twenty cases of tabes at various stages, the normal graph being overlaid in dotted lines. It will be seen that in all the points of the lower extremities there was a decided diminution. The highest record over the sacrum was four seconds, while the lowest in the normal is never below ten seconds. It will be further noted that while there was a time reduction in the upper extremity, it was by no means so marked as in the lower extremities. It was a notable fact that in no case of tabes was this sign of lowered vibration response over the sacrum absent. In a number of cases a careful search failed to reveal

the areas of analgesia which were expected. In such cases the diagnosis of tabes was justified by a study of the cerebro-spinal fluid, which showed the usual changes incident to syphilis.

After a study of a number of cases of tabes I began to feel that a diminution in the time of the vibration response with the windowed instrument over the sacrum in the presence of a positive Wassermann reaction of the cerebro-spinal fluid was pathognomonic of tabes. As the number of cases has increased



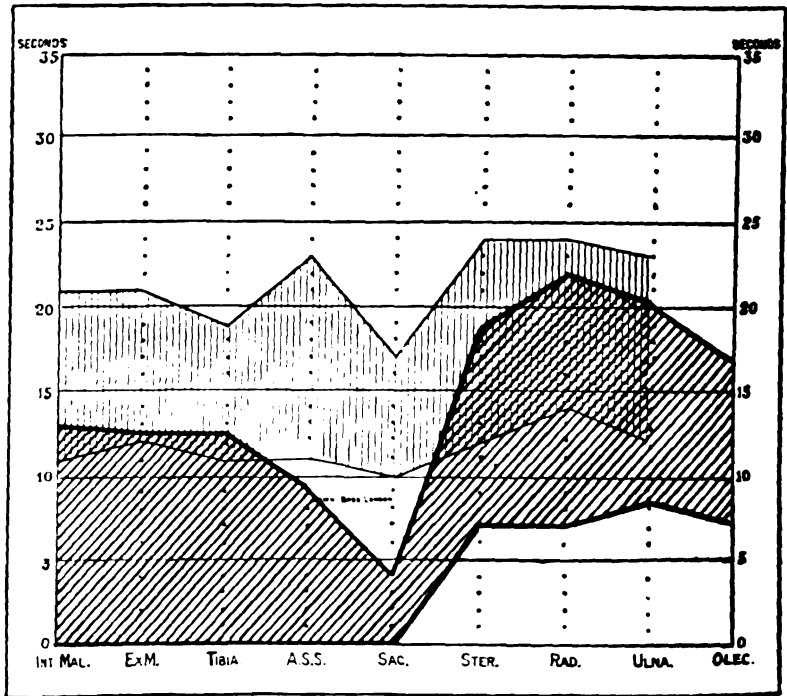
GRAPH 5.

Three brothers. Two definitely had Friedreich's ataxia, the third doubtful.

this view has been strengthened. In no other condition will a diminution in the time response over the sacrum occur except in an occasional case of sub-acute combined degeneration of the cord or in a case of paraplegia where there is general sensory disturbance. It would seem reasonable to suspect such a time reduction in a lesion of the cauda equina, and one such case is now under observation. It will be appreciated, however, that if this reduction over the sacrum occurs in all cases of tabes it will form a most valuable aid in diagnosis. This point is specially important in the light of the fact that it has

occurred in cases so early that the disease had not been suspected, even though they were under careful observation. It is my own opinion that this time reduction occurs in tabes before the appearance of areas of analgesia as well as before the presence of the Argyll Robertson pupil, and before the disappearance of any of the tendon reflexes. Such a claim to be justified must be confirmed by many observers in many cases.

The spinal fluid must be the pivotal point in presenting



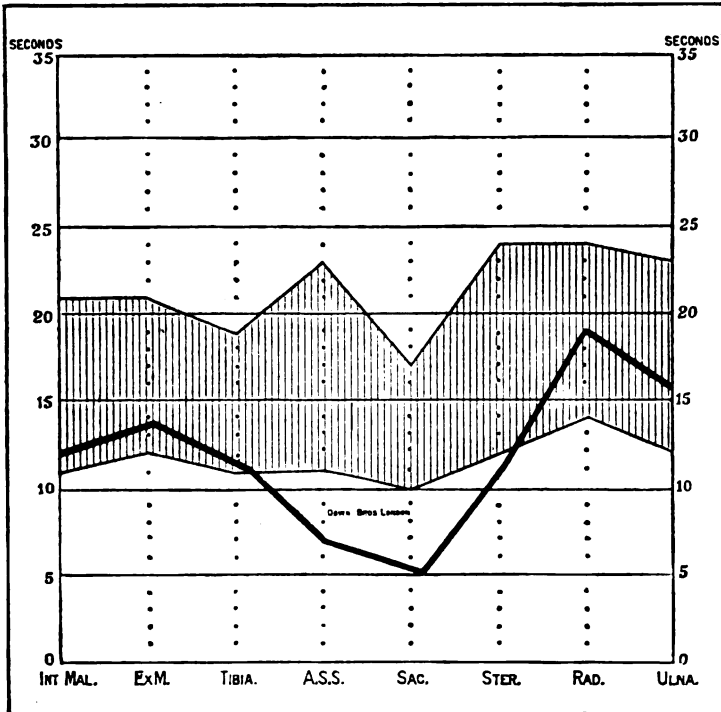
GRAPH 6.

Twenty cases of tabes.

such a claim as this. I feel confident, however, that with a marked reduction of the sacral response, and a coincident positive Wassermann reaction of the spinal fluid, the diagnosis of early tabes can be made with a considerable degree of certainty. Certainly, in the presence of this reduction and a positive spinal fluid there is as much reason to expect the later appearance of the tabetic picture as there is to expect tabes in the presence of the Argyll Robertson pupil, as was claimed by Nonne, when all other tabetic symptoms were wanting.

The following case illustrates the point in question. A man

of fifty-five years was found to have an aneurysm of the arch of the aorta. The blood was negative to the Wassermann reaction, but the spinal fluid was strongly positive. The pupils were normal, responding to light and accommodation. The tendon reflexes were all present. No areas of skin analgesia were found. There were no symptoms suggesting crises or lightning pains. Graph 7 shows the marked reduction in the vibration sense over the sacrum and the lower extremities.



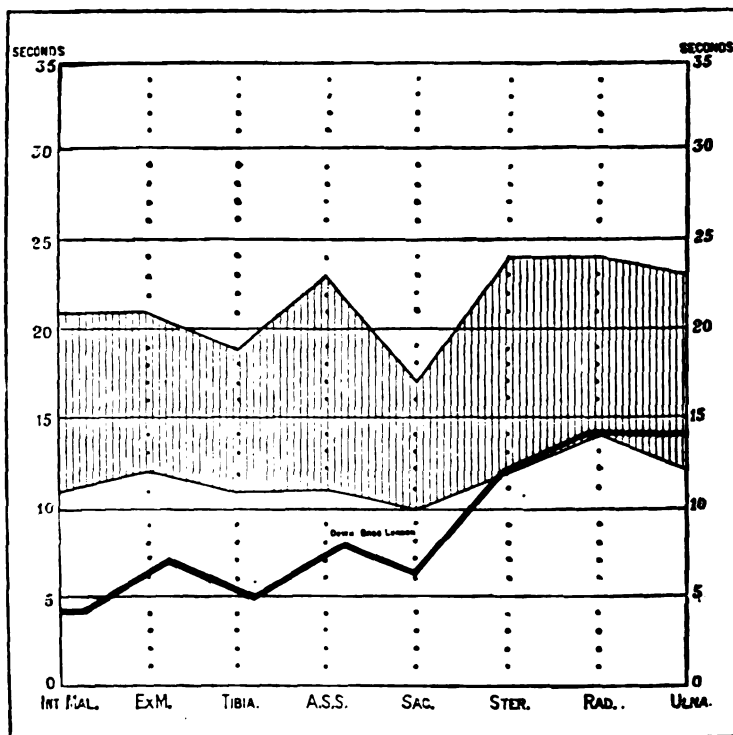
GRAPH 7.

Aneurysm of the arch of the aorta. Blood negative Wassermann, but cerebro-spinal fluid strongly positive. No Argyll-Robertson pupils. Knee and ankle jerks present. No areas of skin analgesia.

This case was later definitely diagnosed as tabes because of the development of disturbances of cutaneous sensation which began over the tibiae. The appearance of analgesia in early tabes appears from the cases studied in this series to follow rather than precede the altered vibration sense.

Graph 8 was made from an old sergeant who had served in India. The Wassermann reaction of the blood was strongly positive, but the knee-jerks and ankle-jerks were present, and

the pupils reacted to light, but unequally. There were no areas of skin analgesia except two tiny spots in the posterior part of the axilla incompletely developed. He was admitted because of attacks of violent epigastric pain. This pain was not connected in time with the taking of food, and the fæces contained no occult blood. The character of the abdominal pain suggested tabes, which appeared to be confirmed by the reduction in time of the vibration sense.



GRAPH 8.

Graph of an old sergeant who had served in India. The only symptom or sign suggestive of tabes was severe epigastric pain. The Wassermann reaction of the blood was strongly positive.

In a number of instances while searching the wards for non-neurological subjects on which to do the test in the establishment of a normal graph, cases have been found in which there was a marked, constant and unvarying reduction in the time response over the sacrum, when the diagnosis of ulcer or neoplasm was being considered. While the number of cases is too limited to justify a definite conclusion, still there seems to be some justification for making an investigation of the

vibration sensation in obscure abdominal cases attended with pain in order to exclude the possibility of early tabes. Before the investigations of Symms this would have been useless, because the alteration cannot be detected with any reasonable certainty unless it is made quantitatively rather than qualitatively.

Nazum² found that in 97 out of 1000 cases of tabes, a needless operation had been performed owing to laryngeal, gastric, intestinal, vesical, urethral and other visceral crises in the preataxic stages having been referred to the wrong source. Exploratory laparotomy has often been performed for supposed gall-stones, gastric ulcer, appendicitis, salpingitis, renal colic and several other intra-abdominal disorders in cases of tabes, in which a proper neurological examination would have prevented it. It is obviously unfair to expect a diagnosis of tabes to be made in cases without pupillary changes and without alteration of the tendon reflexes and in the absence of areas of analgesia. Such cases, however, may show a positive Wassermann reaction of the spinal fluid, though this is seldom investigated except in neurological cases. It is at this point that the usefulness of the quantitative determination of the vibratory sensation seems to be best exemplified. Certainly a variation from normal with this simple test would indicate an examination of the cerebro-spinal fluid, which might reveal the presence of tabes when the only symptom was a crisis.

One of the most interesting observations made in the study of tabes was the alteration in the time of vibration, in those patients who had been under vigorous anti-syphilitic treatment for a period of three months after the vibration investigation was first made. It was found that in a number of such cases there was a definite indication of improvement in the appreciation of vibration, as shown by a time difference of from two to four seconds. It would be an interesting field for further study to keep accurate records of the vibration sense during prolonged treatment.

CONCLUSIONS

1. A definite range of normal variation of the vibration sensation is established.
2. Variations from the normal occur in several nervous diseases, notably multiple neuritis, tabes, and subacute combined degeneration of the spinal cord.
3. A "sacral notch," which was a marked exaggeration of

the normal dip at this point, was present in the graph in every case of tabes studied; it appears to be the earliest clinical indication of the disease, and with a positive Wassermann reaction in the cerebro-spinal fluid justifies a diagnosis of tabes, even in the absence of all other signs and symptoms.

Wilmington, North Carolina, U.S.A.

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DIAPHRAGMATIC HERNIA

By R. P. ROWLANDS, M.S., Surgeon to Guy's Hospital.

ALTHOUGH over a thousand cases of diaphragmatic hernia have been recorded, the condition remains a pathological curiosity, for the large majority of cases have been infants born dead or dying soon after birth. Comparatively few have been recognised during life. Fewer still have been treated surgically, and most of the operations have been unsuccessful. Marshall Lloyd found only two cases recorded in the surgical reports of Guy's Hospital between 1866 and 1920. Both were due to crushing, and the patients died shortly after admission without an operation. No surgeon has had personal experience of more than a few cases; it is therefore important that every case should be published so that its clinical recognition and treatment should be put on a firmer basis. The following is an account of a case shown by me at the Clinical Section of the Royal Society of Medicine on November 12, 1920. It is one of the very few congenital cases which have been diagnosed and have recovered after operation.

Thomas M., aged nineteen, about eight months ago first began to get pains in the epigastric region about an hour after meals, sometimes accompanied by vomiting. The pain was considerably relieved when in the left recumbent position. Since the onset the period between meals and onset of pain has become lessened, and now he experiences pain directly after meals. There is much flatulence. If he finds the pain is not allayed after meals he induces vomiting. There has been no hæmatemesis, and the bowels are regular. There has been no respiratory distress. About six months ago the patient was operated on elsewhere for supposed gastric ulcer. The stomach was found fixed high up in the epigastrium. The condition was not diagnosed, and the abdomen closed without further interference. Three weeks after the operation the pains became the same as before. On admission to Guy's Hospital the patient was very thin and anæmic. Definite sinking in of the epigastrium was observed, and the abdomen moved well. There was no tenderness, and no abnormality on palpation. The lower ribs were unduly prominent on the left side in front, this being

limited above by a sulcus running transversely at the level of the episternal notch, like a unilateral Harrison's sulcus. The patient had noticed this for six months. The chest otherwise looked normal. The heart appeared to be normal. On percussion normal resonance was found over both sides except below the scapula on the left side, where the note was tym-

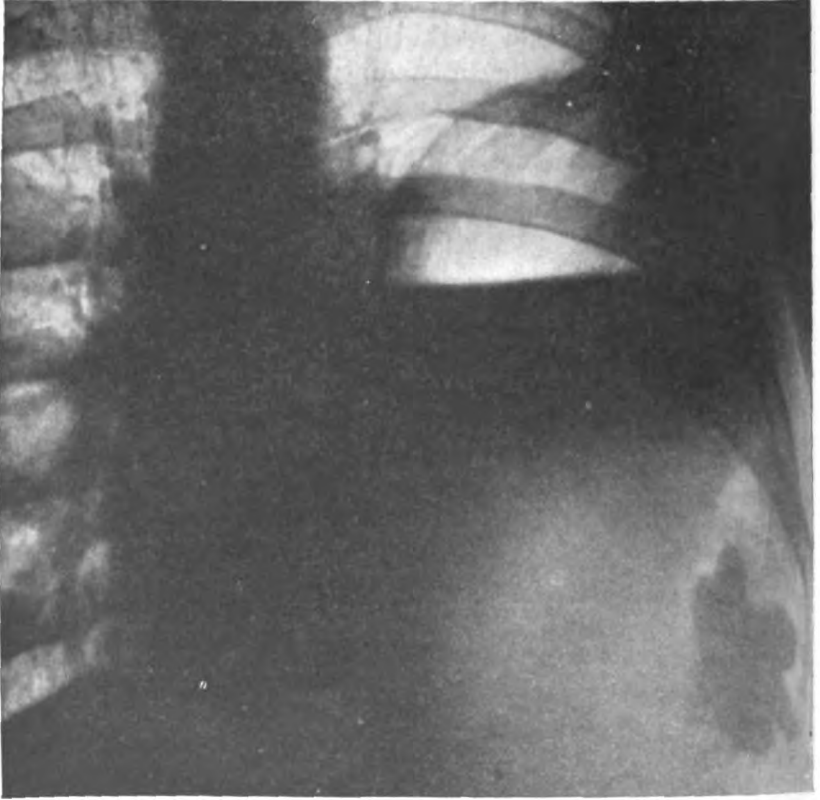


FIG. 1.

Radiogram taken October 1, 1920, showing the stomach and splenic flexure of the colon above the diaphragm. Lung tissue is visible through the "gas bubble" in the stomach. The very curved line of the upper wall of the stomach is characteristic. The opacity in the colon represents the remains of a meal given nearly two days before.

panic and at the left base where the note was impaired. Air entered all over both sides, but the air-entry and voice sounds were weak at the left base. No borborygmi or metallic tinklings were heard in the chest. Mr. M. Coburn suspected diaphragmatic hernia, and sent the boy to be radiographed.

The x-ray examination on October 1, 1920, by Mr. J. M. Redding, showed that the œsophagus passed down to the level of

the lower border of the eleventh dorsal vertebra and then turned to the left to join the stomach. The whole of the stomach lay above the diaphragm, the fundus behind and the pylorus antero-internally (Fig. 1). The œsophagus entered the fundus at its lowest part. The motility of the stomach was good, and the meal left normally, but the duodenum did not appear to follow its normal course; none of the small gut appeared to be above the diaphragm. Some of an opaque meal given on a previous day was now seen in the splenic flexure above the diaphragm. The stomach was empty in five hours.

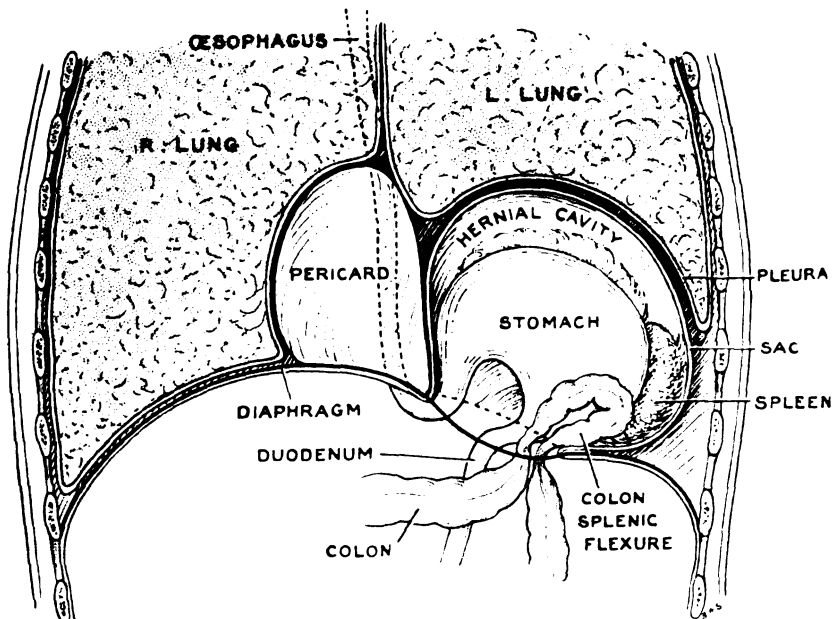


FIG. 2.
Diaphragmatic hernia.

The operation was performed under intra-tracheal ether, the patient lying on his right side. An eight-inch incision was made over the eighth left rib, which was removed sub-periosteally, and the chest opened, displaying a large serous cavity occupying the lower two-thirds of the left chest. Through the upper thin wall of this cavity the base of the lung could be seen, but it was not in the cavity, which contained nearly the whole of the stomach, the splenic flexure of the colon and the spleen. There were some adhesions between the stomach, the great omentum and the wall of the cavity, and especially binding the spleen and colon to the back and left side of the cavity and the edge of the opening in the diaphragm (Fig. 2).

The surface of the stomach was inflamed and bruised near the pylorus from friction against the front and inner edge of the opening. The latter was four inches long and one inch wide, and placed near the back of the diaphragm, extending downwards and outwards to the chest wall from near the œsophageal opening of the diaphragm. Its edges were thick

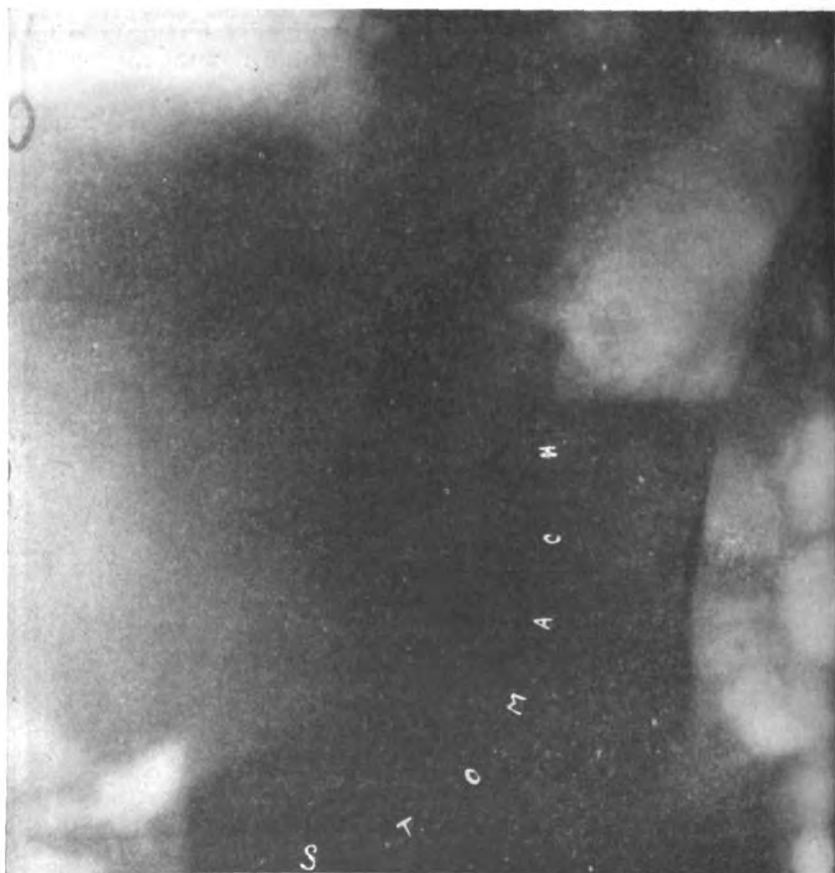


FIG. 3.

Radiogram taken October 22, 1920, showing the stomach in the abdomen, and the barium entering it through the diaphragm, the normal "bow-line" of which has been restored.

and smooth. The anterior edge was much more definite than the posterior. The opening was clearly congenital and consisted of a slit between the lumbar and costal muscular fibres. After separating the adhesions and tying many of them, the viscera were returned into the abdomen and the opening of the diaphragm closed with many cat-gut sutures. The parietal opening was then completely closed without a tube.

The patient was somewhat shocked after the operation, but revived after saline enemata, and the pulse never went above 120. The wound healed well. The patient got up and walked fourteen days later. He has improved generally in health since and has put on weight. His symptoms have been completely relieved.

The x-ray report, on October 22, stated that "there is a

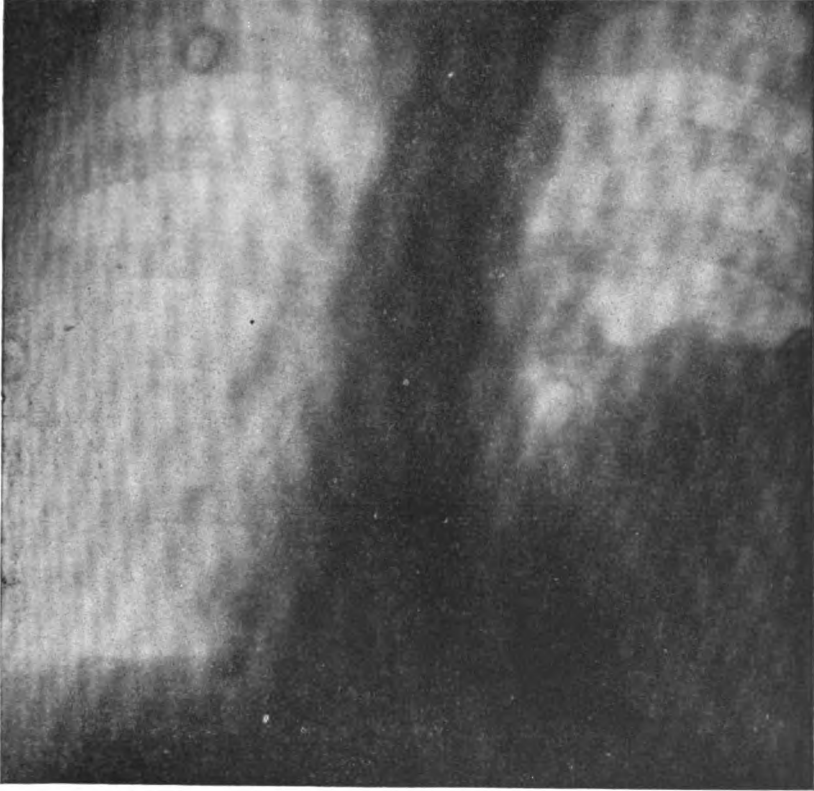


FIG. 4.

Radiogram taken October 22, 1920, showing large opacity at the left base, probably due to blood-clot in the hernial sac.

large opacity at the base of left lung, which is probably caused by pleural thickening or blood in the old hernial sac. The opaque meal passes freely through the oesophagus into the stomach, which is lying in normal position in the abdomen and shows no abnormality." (Figs. 3 and 4.)

A further radiogram taken on November 11 (Fig. 5) showed a marked diminution of the opacity in the left chest, proving that the lung was expanding quickly.

Ætiology.—Diaphragmatic hernia may be congenital or acquired. Out of 433 cases analysed by Grosser and Thoma 232 were congenital and 181 acquired, but it is often very difficult to settle this point. Few subjects of congenital hernia survive, and in those that do the symptoms may come on insidiously for years and culminate in an acute attack of strangulation or obstruction of the stomach or intestine. The

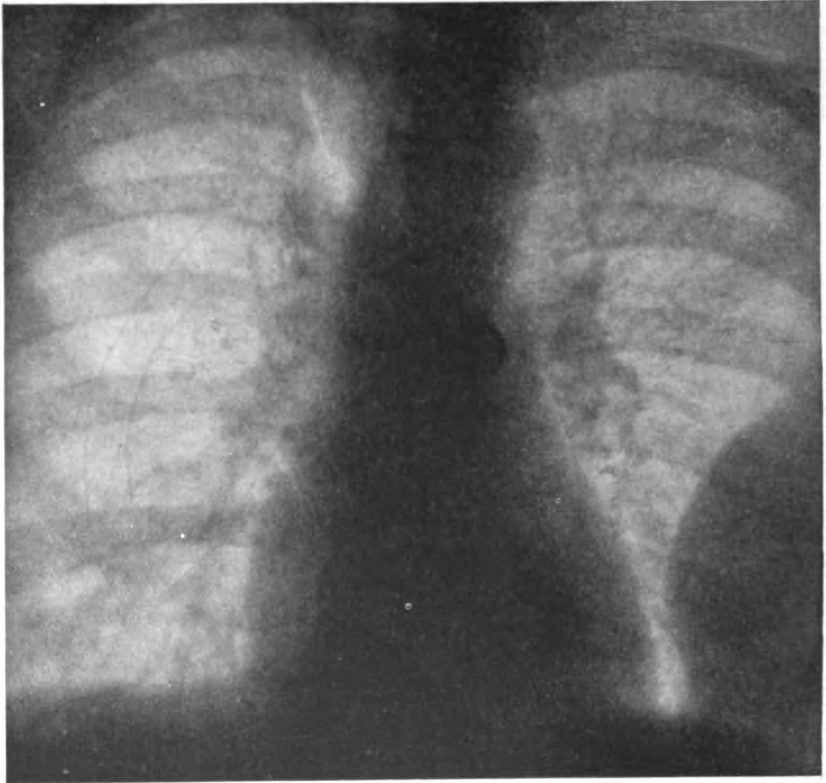


FIG. 5.

Radiogram taken November 9, 1920, showing the opacity at the left base to be rapidly diminishing and the left lung expanding.

acquired or traumatic variety follows a wound or laceration of the diaphragm due to direct or indirect violence, such as violent crushes or gun-shot wounds; the latter have accounted for many cases during the war.

The hernia may be true or false. If true, it possesses a sac formed of peritoneum or diaphragmatic pleura or both; but in most instances it is false and has no sac, the stomach being in contact with the lung.

Most of the clinical cases have been recognised at opera-

tions undertaken for some emergency, such as intestinal or pyloric obstruction. In many cases even laparotomy has failed to reveal the hernia, or, having discovered it, the surgeon has sometimes been unable to reduce its contents or close the gap in the diaphragm.

As pointed out by Keith¹ the diaphragm is developed from five segments (Fig. 6), a mesial and two lateral on each side which join together. Large or small gaps may be left between any of these segments, especially between the lumbar and the costal parts behind (foramen of Bochdaleki), and, more rarely,

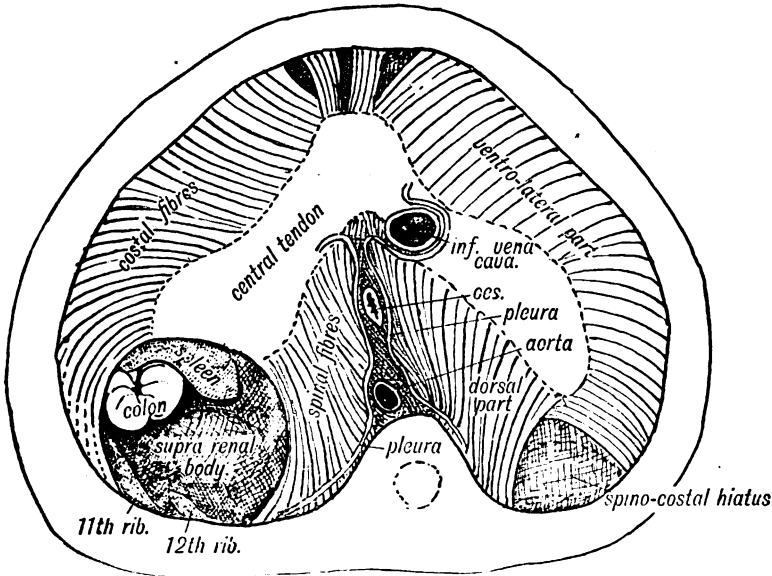


FIG. 6.

Diagram illustrating development of diaphragm (Keith).

between the sternal and costal parts in front (foramen of Morgagni). In most congenital cases there is a direct opening from the peritoneum into the pleura on the left side (*vide* Fig. 6). In a personal letter Prof. A. Keith kindly writes:—"It is just possible that there may occur in the human diaphragm two other congenital openings besides the two usual (pleuro-peritoneal) ones. These ventral pericardio-peritoneal passages do not form in the human embryo, but as they are normal in certain fishes they ought to occur especially in man. They should always open into the pericardium; all other openings are the result of injury." Apart from such definite apertures these gaps in the muscle are weak spots which may give way when the

abdomen is crushed. In some cases the hernia is through the œsophageal opening.

The condition is eight times more common on the left than on the right side owing to the protection of the liver. Usually a small projection of the liver only is found in a right-sided hernia, but the stomach has been found in the right pleura, and, in at least one instance, the hernia has passed into the pericardium.

The contents of a diaphragmatic hernia vary very greatly. The stomach, great omentum and the splenic flexure of the colon are the most common, but the spleen, small intestine, tail of the pancreas, and even the greater part of the large intestine may be in the hernia. Adhesions are apt to form in the hernia, and dilatation, ulceration, or even perforation of the stomach or intestine, may be caused by obstruction at the hernial orifice.

Signs and Symptoms.—These vary greatly, depending chiefly on the contents of the hernia, and the presence or absence of obstruction of the stomach or small or large intestine. In acute cases dyspnœa, severe thoracic pain, and cardiac distress may be evident from interference with the left lung and displacement of the heart. When the stomach or pylorus is obstructed or strangulated, vomiting, which is sometimes frequent and severe, hæmatemesis, severe epigastric pain and a carinated abdomen are noticed. Sometimes there is dysphagia from obstruction of the cardia. Wilks² drew attention to excessive thirst as a suggestive symptom of strangulation of the stomach. When the obstruction concerns the intestine, and especially the colon, some of these symptoms may be absent, and replaced by those of intestinal obstruction, and the abdomen may be markedly distended. The possibility of a diaphragmatic hernia should therefore be remembered, especially when the cause of obstruction cannot be made out during an exploration.

In chronic cases the symptoms often come on insidiously and are less clear. Tympanites, extending high into the chest, gurgling, splashing, metallic tinkling, and distant breath and voice sounds over the lower part of the left side have been noted. The upper part of the chest is usually normal or hyper-resonant.

Diagnosis.—The history and signs of a wound or an injury are of great assistance in acquired cases. Often diaphragmatic hernia has been mistaken for intestinal obstruction due to other causes, or for gastric ulcer with or without pyloric stenosis, the symptoms being due to compression of the stomach or pylorus, or even to actual secondary ulceration. In several cases it has been mistaken for gall-stones. Eventration or chronic “idio-

pathic " elevation of the left side of the diaphragm—of which only twenty cases have been recorded, pneumothorax, hydropneumothorax, hæmo-pneumothorax, and pyo-pneumothorax have caused real difficulties in diagnosis, and a diaphragmatic hernia has been tapped or incised in error. In diaphragmatic hernia the breath and voice sounds are scarcely diminished, whereas they are absent in pneumothorax, and metallic tinkling is associated with peristalsis and not with respiration. Moreover gastric disturbances are not marked with pneumothorax. Œsophageal pouch and stricture of the Œsophagus have also been confused with diaphragmatic hernia. Out of 650 cases discussed by Giffin³ only fifteen were correctly diagnosed during life.

The x-ray appearances are by far the most important aids in the diagnosis. An opaque meal may definitely show the stomach to be above the diaphragm. Above the barium in the stomach the usual gas bubble is easily recognised, bounded by a definite curved line, indicating the wall of the stomach. This must not be mistaken for the usual bow line of the diaphragm, which is much lower and less acutely curved. In these cases the outline of the diaphragm is rather indefinite and irregular on the left side, and it does not move well on respiration; the left cupola may move up while the right moves down during inspiration. On careful observation lung tissue may be seen through the air bubble above the opaque meal. This is most valuable in distinguishing diaphragmatic hernia from eventration and all the varieties of pneumothorax. The administration of a seidlitz-powder by the mouth may help this examination by distending the stomach with gas. An opaque Œsophageal tube may be seen to pass up again through the diaphragm into the part of the stomach in the hernia. After an opaque enema has been given the splenic flexure of the colon may be shown above the diaphragm, and in some cases it has been seen to reach as high as the clavicle. This is conclusive evidence of diaphragmatic hernia.

Operation.—Without an operation the outlook is usually very bad, but a few patients have survived for many years and have ultimately died from other causes, the condition being perhaps first discovered after death.

When performing an operation there are three routes to choose from: (1) abdominal, (2) thoracic, and (3) a combination of the two.

(1) Very few operations have been deliberately undertaken with the diagnosis already made; out of fifty-three operations done, in only six was a correct diagnosis made beforehand. In

most cases the abdomen has been opened for intestinal or gastric obstruction, and the hernia discovered in this way. The abdominal route has therefore been used more frequently than the thoracic, but it certainly does not seem to be always the best route, for even when the abdomen has been opened the true condition has often remained undiscovered. In many cases it has been impossible to bring the contents of the hernia back into the abdomen, owing to adhesions in the sac and powerful thoracic suction. This force is so strong that, even when the hernia has been reduced, it has sometimes been found impossible to prevent the immediate return of the viscera into the chest. Closing the aperture in the diaphragm from below has also been very difficult or impossible. In several cases such makeshifts as sewing the stomach to the edges of the aperture, to the abdominal wall or to the right flank have had to be adopted even by very skilful surgeons. Gastro-jejunostomy has been performed after failing to bring the greater part of the stomach and pylorus back into the abdomen. The abdominal route has, however, the advantage of allowing a complete exploration of the abdomen in acute and traumatic cases, but in chronic cases this exploration is rarely required. The best abdominal access to the left side of the diaphragm is given by a long, oblique incision, one inch below and parallel to the left costal arch.

(2) The thoracic route provides by far the most direct access and the best view of the contents of the hernia and of the aperture in the diaphragm. It makes the separation of adhesions easier and far safer; it abolishes the thoracic suction, which is so powerful a hindrance to reduction from the abdomen if the chest is not opened also, and it makes the suture of the aperture a comparatively easy operation. A long incision should be made, either through the eighth left intercostal space, or the greater part of the eighth rib should be excised and good retractors used—such as those of Tuffier. Several surgeons have raised a flap, including about five inches of the seventh or eighth left ribs, but the simpler incision is probably the better.

The thoracic route is clearly the best for chronic cases. Cranwell,⁴ Carson,⁵ Barton⁶ and others have successfully adopted it. In fifty-two recent traumatic cases without strangulation, analysed by Binnie,⁷ the mortality for the thoracic route was only 9·6 per cent., compared with 50 per cent. for the abdominal route; in cases with strangulation the mortality was 50 per cent. for the thoracic route and 100 per cent. for the abdominal (Neugebauer).⁸ Seudder⁹ analysed fifty-five operations—eleven thoracic with seven recoveries, and forty-two abdominal with seven recoveries. It is probable, however, that the abdominal

route was adopted in the most severe cases on account of signs of associated injuries in the abdomen.

(8) Neugebauer, Moriston Davies¹⁰ and others have extended an abdominal wound near the left linea semilunaris up through the costal arch to the chest. This appears unnecessarily severe. Others have made separate abdominal and thoracic incisions after failing to reduce the hernia through one only.

Whichever route is adopted it is most important to maintain asepsis, to stop all bleeding, and to close the chest completely, in order to prevent secondary infection of the large cavity left in the chest. Great care and patience are required to close the hernial aperture completely. Numerous Lembert sutures passed from above the diaphragm are very effective. When the gap is very large a fascial graft may be used.

Elevation of the chest naturally helps the reduction of the hernia, and insufflation or intra-tracheal anæsthesia, although not indispensable, is of undoubted value during the operation, for it greatly diminishes the respiratory movements of the chest and abdomen.

The air or secondary aseptic effusion replacing the hernia in the thoracic cavity is gradually absorbed, or, failing this, it may be aspirated. The lung as a rule expands very slowly, for it may be atelectatic, bounded by an adherent sac, or congenitally small. In one case it was entirely absent.

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NOTE ON "EVENTRATION OF THE DIAPHRAGM"

WITH DESCRIPTION OF A CASE OF UNILATERAL ELEVATION OF THE DIAPHRAGM WITH HEART PUSHED OVER TO THE RIGHT, CAUSED BY DILATATION OF THE SPLENIC FLEXURE

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital.

IN his paper on Diaphragmatic Hernia Mr. R. P. Rowlands follows Giffin in discussing its differential diagnosis from the condition described by Petit in 1790 as "eventration of the diaphragm." By eventration is meant "chronic idiopathic unilateral elevation of the diaphragm,"—an unsatisfactory term,

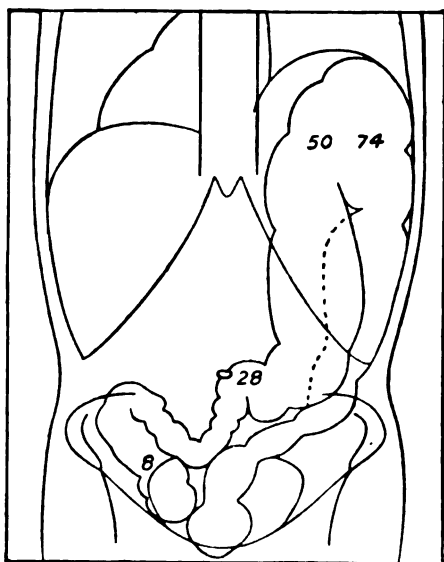


FIG. 1.

Heart pushed over to right side of the chest
by dilated splenic flexure.

as eventration should mean a condition in which a part of the abdominal viscera is outside the peritoneal cavity. "Eventration" might indeed be applied to diaphragmatic hernia more aptly than to abnormal elevation of the diaphragm. According to Giffin only twenty cases of eventration of the diaphragm have been described; he does not appear to have seen a case himself, and Mr. Rowlands tells me that he also knows nothing of the condition from personal experience. The condition is said to be congenital, but the symptoms by which it has

been recognised are so vaguely described that it is impossible to form an accurate clinical picture of it.

In 1914 I saw a case in which the most prominent symptom was unilateral elevation or "eventration" of the left side of the diaphragm, so extreme that the heart was pushed over to the right, and in which the x-ray appearances at first suggested the presence of a diaphragmatic hernia (Fig. 1). Further investigation showed that the high position of the diaphragm was due

to an extreme degree of dilatation of the splenic flexure (Fig. 2).

An exactly similar case has recently been described by Carnot and Friedel¹ (Fig. 3), who had not seen the description of my case and regarded theirs as unique. It seems to me probable that our cases are really examples of the condition described as eventration of the diaphragm, which is therefore not "idiopathic," and Carnot and Friedel actually refer to the "éventration du diaphragme," which was caused by the dilated splenic flexure in their case.

Heart pushed over to the Right Side of the Chest by Dilated Splenic Flexure.—

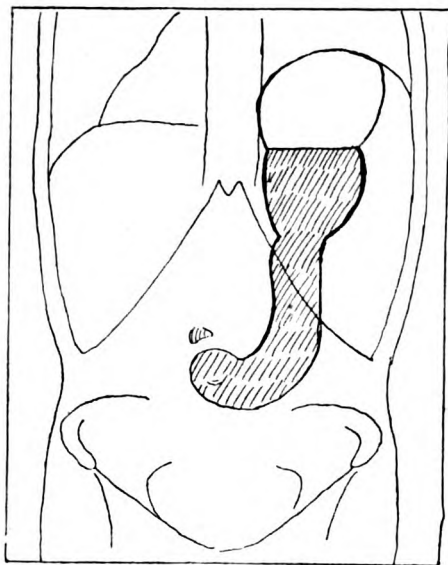


FIG. 2.

Stomach with "eventration" of fundus.

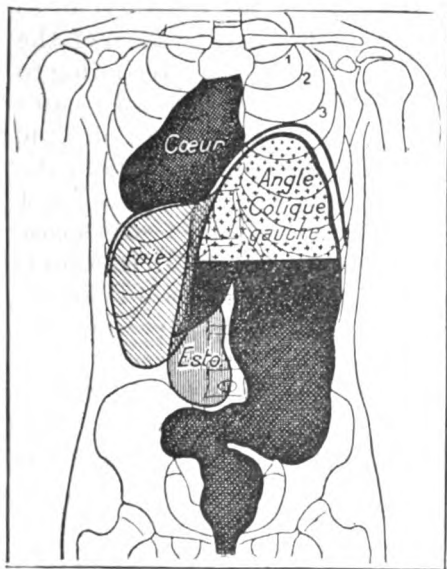


FIG. 3.

Heart pushed over to right side of the chest by dilated splenic flexure (Carnot and Friedel).

highest point of the left side of the diaphragm reached the level of the third costal cartilage, that of the right side being

A lady, aged fifty, had suffered from severe constipation for many years, and on one occasion had gone twenty-six days without an action. I found that her heart was situated entirely on the right side of the chest, but her medical attendant was quite certain that the last time he examined her, some years before, it was in the normal situation. Neither physical examination nor the x-rays showed the presence of anything in the right side of the chest which could have drawn the heart over, or on the left side of the chest which could have pushed it over, but the

only on the level of the fourth intercostal space. This abnormal position was due to enormous dilatation of the splenic flexure; the constipation was found to depend entirely upon delay in the dilated part of the colon (Fig. 1). There was no evidence of any organic obstruction.

Massage of the part of the dilated colon, which the patient could bring within reach by breathing deeply, resulted in considerable improvement, so that she was able to keep her bowels regular with an infusion of six or eight senna pods and a tablespoonful of paraffin every night. Her general health also improved, but there has up to now been no change in the position of the heart.

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A CASE OF TRAUMATIC SUBDURAL HÆMORRHAGE

By W. H. BOWEN, M.S., Assistant Surgeon to Addenbrooke's Hospital,
Cambridge.

C.O., aged sixty-seven, an agricultural labourer, was admitted to Addenbrooke's Hospital on July 27, 1918, suffering from head symptoms, which one of my medical colleagues, who went out to see him in the country, thought were probably due to intracranial compression following on an accident six weeks earlier.

The history given by his friends was that on June 10 (forty-seven days before) he fell off a horse on to the road, fracturing his left clavicle and bruising the left parietal region of the skull. A definite raised lump was present over the site of the head injury for some days after the accident. It is clear from the history that the fall was not caused by any transient unconsciousness, for he remembered pitching on to the left shoulder before he lost consciousness. He was found unconscious by neighbours, but soon recovered and was able to walk home with assistance.

He got on well for a month, and then his wife noticed that he was becoming drowsy and that he staggered in walking. Nevertheless until three days before admission he got up daily and smoked his pipe. For the last twenty-four hours before admission he was in a semi-comatose state. There was no incontinence and he could be roused. He had complained of severe headache.

On admission to the hospital I noted that he was in a state of stupor, but could be aroused by a loud voice. The pupils were equal and of moderate size. When he was told to move his right leg and the limb was tapped to call his attention to it, he moved his left leg. It was found, however, that he could be made to move the right leg, but very sluggishly. On this side Babinski's plantar reflex was sometimes extensor, sometimes flexor. There was no ankle clonus. Owing to his semi-coma it was difficult to get hand grips, but it was thought that the right upper limb was not as strong as the left. There

was neither incontinence, vomiting nor irritability present. The pulse was 60 and regular, and breathing 20 and easy.

Clinically the case is a typical example of the Class A group of traumatic subdural hæmorrhage analysed in my paper published in Vol. LIX of *Guy's Hospital Reports*.¹ A case of comparatively slight head injury with apparent recovery is followed by the late onset of signs of pressure on the brain. This is a clinical picture of subdural hæmorrhage, and it was possible to make a definite and dogmatic statement that beneath the dura mater over the left Rolandic area there was a collection of blood or blood-stained serum, the result of the injury of forty-seven days' before. The reasons for the confidence in locating the hæmorrhage below the dura mater (subdural) rather than outside the dura mater (extradural) were briefly: (1) the comparatively slight nature of the original injury, the rapid recovery from the primary unconsciousness, and the absence of any sign of fracture of the skull; and (2) the long latent interval.

Let us consider these two points a little further. It has to be allowed that an extradural collection of the blood from middle meningeal hæmorrhage has followed comparatively trivial injuries. The first three cases published in Jacobson's classical paper² on the subject are striking examples, but in these cases the lucid interval was short—hours to a few days. Also there is no *latent* as contrasted with *lucid* interval; that is to say, the paralytic focal phenomena are practically synchronous with the onset of coma.

A short digression is justified on the subject of the "latent" interval. The term "lucid" interval has been recognised for many years. In Cock's case of extradural hæmorrhage, which he successfully trephined, reported in the *Guy's Hospital Reports*³ for 1842, the patient had a definite lucid interval. Its relationship to diagnosis is not referred to, although as an introduction to the report of the case the difficulties of diagnosis of the varieties of head injuries are commented upon. Despite this, however, one is led to believe from the reference to another case only cursorily mentioned that the significance of the interval of consciousness or lucidity (Jacobson) was recognised as of diagnostic importance. In Jacobson's paper the lucid interval is clearly recognised, being considered very fully under a separate heading, "The Interval of Consciousness or Lucidity." It seems probable that this authoritative paper first brought into prominence and firmly established the diagnostic significance of this delay of onset of symptoms. When analysing the cases

for my original paper on *Traumatic Subdural Hæmorrhage*, it was recognised that the signs of onset of compression of the brain by the blood might not be loss of consciousness, but some other clinical sign such as paralysis, aphasia, etc. The interval of consciousness or lucidity might only end with an anæsthetic precedent to operation. Recognising this as a clinical fact I coined the word "latent interval" as being that interval of time between the original injury and the onset of definite objective symptoms pointing to compression of the brain. By contrast the lucid interval (interval of consciousness or lucidity of Jacobson), ends when the patient merges into a state of unconsciousness, which terminates either in death or relief by operation. In middle meningeal hæmorrhage and other origins of extradural hæmorrhage the latent and lucid intervals practically terminate at the same moment. Close observation may enable the surgeon in some cases to recognise some parietic phenomena before unconsciousness supervenes, but any such interval between the paralysis and coma is so short and indeterminate in ordinary practice as to be negligible.

When we come to subdural hæmorrhage, however, such a distinct interval between the first phenomena of paresis and the onset of coma may be very pronounced. Of this the case now reported is an exceedingly good example. The latent interval may be said to have ended a month after the accident, whereas the lucid interval may be said only to have ended immediately precedent to operation and scarcely completely even then.* This long-delayed latent interval, with the lucid interval absent or incomplete, is a characteristic of that type of subdural hæmorrhage coming under Class A in my original paper, and of which the case reported here is a very typical example. A comparatively trifling injury, a long latent interval, with a definite recognisable period of time between the ending of the latent and lucid intervals, and with the lucid interval possibly never fully ended, may be said to be very typical of one class of traumatic subdural hæmorrhage, and from the point of view of diagnosis probably far the most important. The remoteness of time from the injury may make the diagnosis one of great difficulty, especially if a paresis has been overlooked and the observer may be faced with a picture of coma or semi-coma. It seems probable that in the past there has been a tendency to rely for diagnosis upon gross

* Case 22 reported in the original paper is an interesting example of a long latent period which ended in hemiplegia. In this case the man retained consciousness up to the time of operation, so that the lucid interval may be said to have been ended artificially on inducing anæsthesia.

physical changes, such as hemiplegia or aphasia, whereas in the future we may hope that diagnosis will be made earlier, being founded on finer rather than grosser deviations from the normal.

To continue the history of the case. The diagnosis permitted of only one line of treatment and immediate operation was decided upon. The upper part of the left Rolandic area was exposed by trephining. When the circle of bone was removed the dura mater was seen to be under tension, without pulsation and blue-grey in colour. There was evidently intradural pressure. The opening in the bone was enlarged by suitable forceps. The dura mater was then incised, when bloody fluid came away under pressure. The opening in the dura mater was then enlarged sufficiently to allow of an exploring finger to be introduced. An extensive cavity was found situated between the brain and the dura mater. In front it went as far as the finger could reach; below, the base of the skull could be felt; behind, the cavity only extended for one and a half inches. It was roughly estimated that at the level of the trephine opening the brain was about one and a half inches from the dura mater. The depression was greater in front of this and less behind. A tube was introduced through the dura mater, to which it was stitched with catgut, and brought out through a small slit made in the skin and muscle flap. The flap was sewn up completely.

Before passing on to the subsequent history it may be briefly remarked that the case was very typical of the conditions usually found at operation. The tense non-pulsating dura mater, discoloured by the fluid underneath it, is characteristic. The fact that it was not blood clot, but rather bloodstained fluid, is also a not uncommon finding, especially in cases where there has been great delay in the onset of signs of compression. In my original paper I went into these matters rather fully, so shall not dwell upon them further now.

At 5.30 a.m. on the morning following operation (July 28) the patient was conscious and able to talk. The reflexes on the right side were normal. In the evening the wound was dressed and the first dressing found to be saturated with a watery fluid. On the 30th the tube was removed and the stitches on August 4. The patient always had antiseptic dressings to prevent any possibility of infection backward through contamination by the skin or even by continuity from the air when free discharge had soaked through to the bandage. He went on well until September 13, when it was noticed he was shaky and upset his food. Being sent to bed he gradually

became semi-comatose and developed paresis of the right arm and right leg with continual twitchings of all his limbs. He could be roused and made to answer questions sensibly and said he had no pain. His coma deepened until he could no longer be roused, and at 9.30 the same evening I re-opened the wound, found the dura mater to be bulging, incised it and found a similar condition to that discovered at the first operation, save that the cavity did not appear quite so large. Treatment was carried out as at the first operation, a drainage tube and antiseptic dressings being used. The operation resulted in perfect recovery of consciousness and movement again, but serous fluid poured out continuously, and we were confronted with the difficulty of choosing between letting the wound close with a probable recurrence of symptoms of compression or keeping it open with the risk of infection taking place. The liability to infection of such a cavity, which is pouring out a fluid, which is probably closely akin to one used for the artificial cultivation of organisms, was realised, and an effort made to avert the calamity of infection by antiseptic dressings and by using every care in preventing the dressings from slipping. Despite this, however, a fortnight after the second operation infection of the cavity was noticed, the temperature rose on September 27, coma supervened, and the patient died on October 10, the symptoms and signs being those of compression rather than of irritation.

An example of the recurrence of symptoms as here set out, with failure to expand on the part of the brain, is not recorded in my original paper. It is a phenomenon which must be very rare, for an extensive literature was examined in the original compilation and no case like it was found. The failure on the part of the brain to expand may partially be explained by lack of resiliency of tissue owing to the patient's age, but this cannot explain the whole matter. If it is carefully considered, I think we are forced to the conclusion that the compression of the brain was of long standing. The compression took place gradually and was an extravasation of serum superimposed on an extravasation of blood. A gradual extravasation slowly compressed the brain, emptying its blood and lymph spaces, and led to degeneration of the highly organised tissue. Thus the mere removal of the external compressing agent was not followed by reflux of blood and lymph, which in the cases of acute compression allows a very rapid recovery.

It will naturally be asked why, if this be so, the symptoms of compression did not come on earlier. The locality of the

clot, the man's age, and his occupation may account for this. It was noted at the operation and corroborated at the post-mortem that the part of the brain most compressed was the frontal lobe. Probably in a younger man, and especially one of a more intellectual type, there would have been changes in temperament or moral tone, which would have presented an interesting picture on analysis.

Fortunately we were able to complete the case by a post-mortem examination, the main points of interest being as follows.

(1) There was no fracture of the skull. The bones of the skull were of less than ordinary thickness, but not unduly thin, and probably not more than might be expected at his age. There was a very good attempt at repair at the trephine hole by thickened fibrous tissue.

(2) Underneath the dura mater was a layer of organising blood-clot a quarter of an inch thick. It gave the impression of being a stage on the way to the formation of a fibrous membrane. Underneath this pseudo-membrane of altered blood, between it and the surface of the brain, was thick pus, which probably replaced a blood-stained serous exudate; internal to this and lying over the brain there was no further layer of altered clot or anything akin to it. This is worth emphasising, for it might very well be thought that this case could be cited as a case transitional to the pathological condition of pachymeningitis interna hæmorrhagica with cyst formation, of which Stanley Boyd's case⁴ and the case reported by James Taylor and Sir Charles Ballance⁵ are the best examples which have come to my notice. Given a layer of clot over the inner surface of the dura and a similar clot over the depressed brain with extravasation of fluid, partly or wholly serous, between the two, and we have the elements for the formation of a pachymeningeal hæmorrhagic cyst. The post-mortem examination of this case is against the view that we had here such a transition stage. One would suggest that the blood clot may have acted as an irritant and led to the pouring out of this serous exudate, possibly in an endeavour to prevent irritation of the surface of the brain.

(3) The brain on section was macroscopically not very different on the two sides. A superficial view led to the conclusion that the grey and white matter were much the same on the two sides and that compression had led rather to emptying of vessels than to any atrophy of tissue. No microscopical sections were made, however, so that minute changes in the framework or nerve tissues, if they had taken place, were not

demonstrated. It is to be hoped that in some future case such an omission may be rectified.

(4) There was no atheroma of the splenic artery or of the arteries of the brain. The aorta had one atheromatous patch with a calcareous plate and early ulceration under it at one side.

(5) The meningitis obscured the picture of the surface of the brain, but not enough to prevent it from being clear that there was no sign of old laceration of the cortex or bruising of the surface or any gross lesion of the brain itself.

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ALOPECIA AREATA

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Introduction.—This communication is based almost entirely on cases of alopecia areata seen in the Out-patient Department of Guy's Hospital over a period of some eighteen months, but a few of the cases referred to were private ones.

It is not proposed to review in detail the various theories that have been suggested concerning the cause of the disease. They are summarised in recent articles by Freshwater,¹ and by Brocq,² and Sabouraud's³ investigations into the etiology are familiar to all dermatologists.

The theory that some *external* parasitic infection of the hair-follicles is responsible is, I think, untenable, in spite of the evidence that has been adduced in its support; Jacquet's⁴ attempts to inoculate the disease were entirely without result, and the histopathology is not in favour of an external infection of the skin.

The neuropathic theory may be, in part, a true one. Joseph⁵ produced bald areas in cats by the excision of the second cervical ganglion, and cases have been described in which the affected parts corresponded to the distribution of a nerve, *e.g.* the first division of the fifth. Sutton,⁶ who quotes an example of the disease following a supraorbital zoster, suggests that it may be analogous to herpes zoster and to anterior poliomyelitis. Jacquet's theory, which attributes alopecia areata to reflex irritation of peripheral nerves, *e.g.* by carious teeth or by certain visceral disorders, is probably but a half-truth, and his observations are capable of another interpretation. The same may be said of Sabouraud's view that the disease is associated with disorders of the ductless glands, particularly of the thyroid.

In my opinion alopecia areata is due usually, if not invariably, to focal infection, the foci being the teeth and gums, the tonsils, nasopharynx, or nasal sinuses in the great majority of cases. I have collected a good deal of evidence to show that the *Streptococcus pyogenes longus* is the usual infecting organism, but it is quite possible that others may sometimes be responsible. Whether the loss of hair is due to the direct action of bacterial toxin on the hair papillæ, or to a toxic

neuritis, or to ganglionic infection as in herpes zoster, is uncertain and immaterial from the point of view of treatment.

ETIOLOGY

Alopecia areata is a common disorder, particularly among children and young adults. Norman Walker found that out of 4000 cases of skin disease alopecia areata occurred in 5 per cent. In America it appears to be less common than in the British Isles. I was able to collect some sixty cases from my clinic at Guy's in the course of about six months, and on an average about four new cases of the disease present themselves for treatment at Guy's every week.

Sex.—Sabouraud found it to be twice as common in males as in females; in my own series of sixty cases the proportion was 62 per cent. males and 38 per cent. females.

Age.—As regard age, I believe that among hospital out-patients the proportion of children to adults is probably higher than in private practice; this may be because children of the well-to-do classes are likely to have early and more efficient treatment for infected tonsils and adenoids than are the children of the poor, and because unsuitable feeding, particularly a disproportion of carbohydrate in the dietary, and overcrowding in insanitary dwellings increase the liability to catarrhal infection.

The following is a summary of my cases (hospital practice)—

Between the ages of	1 and 10 years inclusive	27.29%	(youngest 4 years)
" "	11 and 20 "	29.54%	
" "	21 and 30 "	29.54%	
" "	31 and 40 "	11.36%	
Over the age of	40	2.27%	

Among my private cases the proportion of adults is much higher.

Heredity.—Sabouraud states that out of 500 cases investigated by him there was a family history of the disease in 20 per cent. To rely on the statements of the patients or the parents is obviously unwise, since conditions other than alopecia areata (*e.g.* ringworm) may be considered by them to be the same disease. I have, however, met with two remarkable examples, in which a mother and child were both affected.

Ex. 1. Mother.—Alopecia began at the age of five years, and for the past five years the scalp has been completely bald. She has a brother, aged nineteen, in whom the disease began a few years ago, and who has now extensive baldness (he was unable to attend for examination). She has severe oral sepsis, and her tonsils are large and very septic. The teeth have been

attended to, but pregnancy has prevented further treatment up to the present.

Son aged eleven.—The disease began as a bald patch two years previous to first attendance at hospital (7.11.19); other patches had appeared recently. *Teeth*, good. *Tonsils*, very septic. Enucleation of tonsils 24.11.19. Cultivation gave pure growth of *Streptococcus pyogenes longus*. Vaccine prepared, and given from 6.1.20 to 19.10.20. Hair growing freely 20.4.20, and the scalp has been normal for some months.

Ex. 2. Mother aged thirty-nine.—Bald patches appeared on scalp at age of ten years, and since then fresh patches have occurred from time to time, but on several regrowth of hair has taken place. She lost her eyebrows eleven years ago. When first seen there was ophiasis, and the eyebrows were completely absent. Several scattered bald patches on the scalp, and a recent one on the vertex. *Teeth*, severe pyorrhœa. *Tonsils*, liquid pus could be expressed from both. To come into the hospital later for treatment.

Daughter.—Bald patch appeared on the scalp at age of three years. Since then has had fresh patches with intervals of regrowth. Ophiasis began two years ago and has persisted. *Teeth*, good. *Tonsils*, very septic. Enucleation 12.5.20. Hair growing well 11.7.20. Not seen since.

Focal Sepsis.—I think that it is hardly possible to exaggerate the importance of focal sepsis in dermatology as well as in other branches of medicine. Unfortunately a great deal of misconception exists concerning the subject, and many think that the doctrine of focal infection is a temporary craze. Most medical men are agreed as to the importance of treating oral sepsis, and the necessity of determining the presence of apical abscesses by x-raying the teeth in doubtful cases is being recognised. But the tonsils, nasopharynx, and nasal sinuses are equally potent sources of infection, and are far more likely to be overlooked. Many seem to think that if the tonsils are not enlarged they cannot be infected; this is a very grave error, since in many cases the small scarred buried tonsil is infinitely more dangerous than the large succulent one. I have known of patients whose tonsils have been passed as normal even by throat specialists, and yet careful examination has shown the presence of pent-up pus in considerable quantity.

When the importance of oral sepsis as a cause of diseases, such as rheumatoid arthritis, gastro-intestinal disorders, certain blood diseases, etc., was realised, many brilliant results followed extraction of the teeth, but unfortunately sound teeth were often needlessly extracted, and disappointment inevitably followed. In many such cases the focus of infection was doubt-

less the tonsils, the removal of which, and the institution of autogenous vaccine treatment would probably have cured the patient. Mollison⁷ has recently shown the great importance of tonsillar sepsis in rheumatoid arthritis.

In dermatology the influence of oral sepsis in the pathogenesis of various dermatoses is now generally recognised, and Darier, in his incomparable *Précis de Dermatologie*, says —

“ Je suis convaincu, pour l'avoir constaté maintes fois, que la remise en bon état des dents, le port d'un dentier bien adapté, l'entretien soigneux de la bouche, peuvent contribuer puissamment à enrayer des poussées éruptives, à améliorer l'état général de beaucoup de sujets, et à permettre la guérison de dermatoses qui avaient résisté à des applications topiques même correctes, et à la prescription d'un régime alimentaire draconien ”—but of no less importance is tonsillar and nasopharyngeal sepsis.

Not only does infection of the mouth, tonsils and nasopharynx lead to the direct absorption of toxin and often probably of virulent micro-organisms into the blood stream, but the constant swallowing of pus causes gastritis and secondary infection of the intestinal tract, whereby a further focus of absorption is created, proper digestion is interfered with, and fermentation of foodstuffs by bacteria set up. Often when the treatment of oral and tonsillar infection has failed to produce the results expected, the cause of failure is due to the fact that the intestines have become a source of infection; needless to say intestinal stasis, if it exists, will aggravate the condition and lead to increased absorption of toxin.

Jacquet's theory of the association of alopecia areata with carious teeth, etc., has been criticised on the grounds that defective teeth are present in the majority of hospital out-patients. Similar arguments have also been put forward by those who criticise the view that rheumatoid arthritis and certain other diseases are due to focal sepsis. Such arguments are futile and merely betray an ignorance of the pathology of infection. It may, however, be pertinently asked why it is that different persons manifest different pathological reactions towards what appears to be the same infecting organism. Why is it, for example, that a chronic infection with the *Streptococcus longus* may in one person produce rheumatoid arthritis, in another colitis, in another endocarditis, in another purpura, in another anæmia, and so on?

The view propounded by Danysz (“Origine, Évolution, et

Traitement des Maladies Chroniques Non-contagieuses") is probably correct, namely, that many chronic diseases, including several dermatoses, *e. g.* psoriasis, certain eczemas and urticarias, scleroderma, alopecia areata, etc., are the result of a chronic anaphylactic state due to the absorption directly into the bloodstream of foreign proteins, such as food substances, bacterial proteins, and albuminoid bodies produced during the incomplete digestion of proteins.

Experimentally it has been shown that if a number of rabbits be injected daily for a period of several weeks with minute doses of some foreign serum, and are then kept under observation, they will gradually present symptoms of chronic diseases of various kinds; some will develop arthritis, other dermatoses with alopecia, others involvement of the nervous system with paralysis, and so on. The same may be said of horses used for the preparation of curative serums, and Petit and Loiseau⁸ have published the results of post-mortem examinations of such animals. For further details reference should be made to Danysz's book, but enough has been said to indicate that alopecia areata may be a chronic anaphylactic phenomenon, the antigen being bacterial protein (probably usually of the *Streptococcus pyogenes longus*) absorbed from the teeth, tonsils, nasopharynx, etc., and may be comparable, in fact, to the alopecias produced experimentally in animals by injection of foreign proteins, bacterial or otherwise. The reason for different manifestations appearing in different persons or animals exposed to the same infection is probably that each individual is from its heredity and its own conditions of life in a different state of "immunity-anaphylaxis" (Danysz), and therefore reacts in a certain way towards foreign proteins; we know that some people are sensitive, say, to egg-white, and such a sensitiveness may be hereditary, but whereas one will react by getting an attack of asthma, another will develop urticaria or eczema.

In my series of cases of alopecia areata the disease was associated with *infected tonsils*, with or without adenoids, alone in 62 per cent., with *oral sepsis* alone in 5 per cent., with *oral and tonsillar sepsis* together in 25 per cent., with *chronic otitis media and naso-pharyngitis* in 2 per cent., with *chronic nasopharyngeal catarrh* without obvious tonsillar sepsis in 4 per cent., and with severe *ethmoidal suppuration* with polypi in 2 per cent.

The high percentage of pure tonsillar infection is probably somewhat misleading, and is accounted for by the preponderance of children among my cases; in adults oral sepsis undoubtedly plays a more important part.

Bacteriology.—Enucleated tonsils, extracted teeth, or swabs from infected gums were examined in Professor Eyre's laboratory and cultures made. In most cases a vaccine was prepared. From infected teeth or gums the predominant organism was always the *Streptococcus pyogenes longus*. From the enucleated tonsils, although the same organism was almost invariably obtained, sometimes in pure culture, it was not always the predominant organism present, and in a few cases was not isolated at all; but it was not always possible to examine the tonsils until some considerable time after enucleation, and the *Streptococcus longus* seems apt to die out quickly. Other organisms found were the *Micrococcus catarrhalis*, *Staphylococcus aureus* and *albus*, *Pneumococcus*, and the *Bacillus influenzae*.

As has already been said, the *Streptococcus pyogenes longus* is, I think, the most likely organism to cause alopecia areata. It would seem to have a particularly virulent effect on the hair, witness the severity of the alopecia that so often follows erysipelas. Moreover, the epidemic of influenza that occurred during 1918-19 was associated more than any previous one with subsequent loss of hair, and one of its chief characteristics was the part played by virulent streptococci, often of the hæmolytic type.

Many of my cases of alopecia areata dated from an attack of influenza, and I have seen several patients with post-influenzal alopecia in whom at first the loss of hair was diffuse, but in whom later typical patches of alopecia areata developed. Recently I have seen a diffuse and severe case of loss of hair, with no actual patches of alopecia areata, in a young man who gave no history of previous acute illness, but his tonsils literally "dripped" pus, and he had secondary catarrhal deafness.

ASSOCIATION OF ALOPECIA AREATA WITH OTHER DISEASES

(1) *Graves' Disease.*—Loss of hair is almost constant in this disease, and a certain proportion of cases are associated with severe and sometimes total alopecia. Apart from this, a considerable number of ordinary cases of alopecia areata exhibit symptoms of hyperthyroidism—flushing, sweating, tremor, tachycardia and fullness of the thyroid gland.

The explanation is not difficult, for in many instances hyperthyroidism and probably true Graves' disease are due to chronic infection, particularly of the tonsils, and may be cured, at any rate in the early stages, by removal of the infecting focus.

Whether excess of thyroid secretion in the blood-stream causes loss of hair, *per se*, just as deficiency may do, is uncertain.

(2) *Rheumatoid Arthritis*.—A certain number of patients with alopecia areata have rheumatoid arthritis, though the association is not such a common one as that between the latter disease and lupus erythematosus, a condition that I believe also to be due to chronic infection with the *Streptococcus pyogenes longus*.

(3) *Herpes Zoster*.—Typical alopecia areata may follow supraorbital zoster, or may co-exist with zoster elsewhere. I have seen a case in which intense right-sided neuralgia of the scalp with extreme tenderness, right-sided facial paralysis, an attack of right supraorbital herpes, and rheumatoid arthritis co-existed in the same patient. The teeth were not infected, but the tonsils were extremely septic. It was not considered advisable to enucleate them owing to the patient's age, but they were cleaned up as far as possible and cultures taken from them: a pure growth of *Streptococcus longus* was obtained, and a vaccine prepared. The early doses of vaccine were followed by considerable reaction with increase of pain in the affected joints, and with each dose a *slight recurrence of the supraorbital herpes occurred*, a point of great interest. The patient developed an attack of acute iritis after the initial manipulation of the tonsils, but this soon subsided, and now there is very great improvement in her joints, and in her facial muscles on the side of the palsy, and she has completely lost her neuralgia. In this case it is obvious, I think, that the rheumatoid arthritis, the neuritis, the herpes, the facial paralysis and the iritis were all due to infection of the tonsils, the infecting organism being a *Streptococcus longus*.

(4) *Vitiligo*.—The association of alopecia areata with vitiligo is too frequent to be merely a coincidence. The etiology of vitiligo is not clearly understood, although exposure to sunlight or the irritation of lice may provoke the pigmentary change. It is probable that, as Pringle and MacDonagh⁹ suggest, the disease is a toxæmia, and there is considerable evidence that the toxin acts on the posterior root ganglia or fibres. It is often apparently associated with syphilis, and may be a premonitory symptom, like herpes zoster, of syphilitic involvement of the central nervous system. In many cases, however, no evidence of syphilis, either congenital or acquired, can be obtained, in which case the infection may be, as with most cases of herpes zoster, a bacterial one.

ILLUSTRATIVE CASES

Alopecia areata is a disease that tends to get well, even if untreated, especially in young persons. Therefore one must be very careful before drawing deductions concerning the value of a certain method of treatment. For this reason, although every case was carefully investigated for focal sepsis, and the appropriate treatment carried out when possible, no conclusions were drawn from *recent* cases or from cases in which regrowth of hair was already taking place. But patients were met with in whom one or more patches had persisted for a year or longer, and in whom there was no evidence of recovery; in some of these removal of an infecting focus or foci, with subsequent vaccine treatment, has been followed by a comparatively rapid regrowth of hair; in these, I think, it is fair to assume that the disease was due to the focal infection.

Case 1. E. C., male, aged twelve.—Had influenza Christmas 1918. In March 1919 hair began to fall, and a bald patch formed on the vertex. Later another patch appeared. When seen at hospital (Dec. 1919) there was typical alopecia areata involving about a quarter of the scalp, and the disease was evidently spreading: no evidence of regrowth. *Teeth*, fair. *Tonsils*, very septic. *Enucleation* Jan. 1920. Autogenous streptococcal vaccine given. 26.2.20, no further spread. 24.3.20, hair growing freely. Complete recovery since.

Case 2. H. M., female, aged thirteen.—Almost complete alopecia of scalp of six years' duration. *Teeth*, good. *Tonsils*, very septic; large adenoid vegetations. *Enucleation* 13.10.19. 18.12.19, hair growing satisfactorily. Recovery.

Case 3. J. C., male, aged twelve.—Alopecia areata of many years' duration. Disease evidently spreading. *Teeth*, good. *Tonsils*, very septic. *Enucleation* 13.10.19. Cultivation *Strept. long.*, *Mic. Catarrh.*, *Staph. aureus*. Autogenous *strept. long.* vaccine given from 28.10.19 to 12.12.19. 8.1.20, hair growing: no further spread. 22.1.20, Hair growing fast.

Case 4. H. R., male.—Complete alopecia in 1918. Regrowth took place, but hair came out again after an attack of "pleurisy" in July 1919. First seen Oct. 1919. Complete alopecia of scalp and right eyebrow; partial alopecia of left eyebrow. *Teeth*, good. *Tonsils*, septic. *Enucleation* 6.10.19. Cultivation *Strept. longus*, *Mic. Catarrh.* Vaccine given. 8.2.20, eyebrows growing freely; some regrowth on scalp. Recovery.

Case 5. G. S., male, aged eight.—Influenza November 1918. Alopecia in patches soon followed. First seen December 1919. Several patches of alopecia areata. *Teeth*, pyorrhœa and caries. *Tonsils*, septic; adenoids present. January 1920, septic teeth removed. February 17, 1920, tonsils and adenoids removed. Autogenous streptococcal vaccine given 30.3.20 to

19.10.20. March 10, 1920, hair growing. Subsequent recovery.

The following case is of interest in that the patient volunteered the statement, without being questioned, that the vaccine injections produced itching and tingling in the bald patches.

Case 6. P. R., male, aged thirty-four.—Several acute recent patches of alopecia areata. *Teeth*, pyorrhœa. *Tonsils*, very septic. Rapid regrowth of hair took place after removal of sepsis and institution of vaccine treatment (*Streptococcus pyogenes longus*), but, as the case was a recent one, no conclusions can be drawn as to the effect of treatment.

Case 7. W. S.—Private case. This patient was an asthmatic, and had had alopecia areata of the scalp and beard region for some months previous to first consultation. Mr. Mollison found severe infection of the ethmoidal cells associated with nasal polypi. Operation performed for the ethmoidal infection. Since the operation, not only has the asthma greatly improved, but the patient himself called my attention to the fact that his alopecia has ceased to spread and a rapid regrowth of hair in all the patches on the scalp and face has taken place.

TREATMENT

It may be said at the outset that, although removal of septic foci and subsequent vaccination have proved successful in restoring the hair even in long-standing cases of alopecia areata, in some patients still under observation regrowth has either not yet appeared or has been only partial. In a few of these it is probable that complete atrophy of the hair-papillæ has occurred in some of the bald areas, and that regrowth is impossible; in others, perhaps, the intestines form a still further focus of infection. It is possible, too, that in women pelvic infection may give rise to the disease.

If the view of focal sepsis be accepted, it is evident that the most important part of the treatment of alopecia areata is to remove as far as possible every source of infection, since, unless this be done, persistent alopecia or recurrent attacks are likely to occur. With regard to oral sepsis an attempt may be made to treat pyorrhœa without sacrificing more teeth than is absolutely necessary, but the opinion of a competent dentist must always be taken on this point; the possibility of the existence of apical dental abscesses should be borne in mind, and x-ray pictures of the teeth taken if necessary.

Infected tonsils should, I think, always be removed unless

there is some definite contra-indication, but a thorough examination by a throat specialist is essential, and only after careful consideration in doubtful cases should the patient be submitted to what is, after all, a very unpleasant operation.

Some cases of alopecia areata seem to depend on chronic nasopharyngeal catarrh without evident tonsillar sepsis, and for these the correction of any nasal deformity, with the institution of autogenous vaccine therapy, is the correct treatment.

If, after careful examination, no definite source of infection can be found—and I have only seen one such case—reliance must be placed on general tonic treatment and local stimulation of the bald patches.

Vaccine Therapy.—It may be asked why, if a septic focus can be thoroughly removed, subsequent vaccine treatment should be necessary. In many cases it is probably not required, particularly if the disease be of recent origin. But, if Danysz be correct in supposing that conditions such as alopecia areata are manifestations of the “immunity-anaphylactic” state, and depend on the production in the tissues of excess of anti-body, then repeated injections of specific antigen are rational treatment, comparable to that of asthma by injections of the proteins of food-substances, animal scurf (*e. g.* cat and horse), and bacteria. In our cases of alopecia areata ordinary vaccines have been given, under Professor Eyre’s direction, usually at weekly intervals; it might, perhaps, be preferable to give a vaccine prepared according to Danysz’s method (*i. e.* heated to 70° C.) at more frequent intervals.

Internal Treatment.—If anæmia be present, iron and arsenic should be given in increasing doses; arsenic certainly appears to be of use, and, if hypochlorhydria exists, the *Liquor Arsenici Hydrochloricus* may be used in combination with full doses of dilute hydrochloric acid. Sutton¹⁰ gives urotropine, and states that his results have been better since he began to employ this drug. In adults in whom there is evidence of nervous exhaustion small doses of bromide, a generous diet, and complete rest with change of air should be prescribed.

Local Treatment.—All one can hope to do by local treatment of the patches is to improve the blood supply by applying irritants. The best is, perhaps, pure carbolic acid or pure lysol, which should be painted on, and the application repeated, when the resulting inflammation has subsided, until new growth appears. A stimulating hair lotion, particularly if pityriasis or seborrhœa of the scalp co-exist with the alopecia, may well be given, *e. g.* Hydrarg. perchlor. gr. jss, Acid Salicylici, Chloral

Hydrat. āā gr. x, Ol. Lavandulæ ℥ ij, Ol. Amygdalæ ℥ ij-v, Acetoni ℥ij, Spirit. ad ℥i.

In severe and long-standing cases—and the “ophiasis” type is usually the most obstinate—the ultra-violet rays may be employed sometimes with considerable success.

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NOTES UPON THE RELATION OF TONSILLAR INFECTION TO CERTAIN CUTANEOUS LESIONS

By A. M. ZAMORA, M.Ch. (From the Throat and Ear Department, Guy's Hospital.)

CERTAIN cases referred to the Throat Department by Dr. H. W. Barber on account of tonsillar infection associated with skin lesions passed through my hands; they included alopecia areata, lupus erythematosus, recurrent urticaria, and some forms of chronic intractable eczema.

The theory put forward by Dr. Barber that these lesions originate in septic foci has received abundant support from this series of cases, and the results, often brilliant, are dealt with by him (p. 112).

These cases were investigated from the point of view of developing—

- (a) a method of determining the pathogenicity of the tonsil, and
- (b) a method of operation suitable to the special requirements of these patients.

(a) ESTIMATION OF PATHOGENICITY OF THE TONSIL

The growing recognition of the importance of tonsillar infection in many general conditions has led to a search for some standard by which the infectivity of a tonsil may be measured, and in the United States, where the subject is much considered, a special instrument for tonsil transillumination has been devised.

It is the object of this paper to establish the fact that, though in certain cases the infection is patent, yet it is only by the most careful observation that it can be excluded. Although many of these cases showed characteristic features of tonsillar infection, *e.g.* fibrous cryptic tonsils associated with cervical adenitis, areas of more or less generalised dusky hyperæmia of fauces and palate, and tonsils containing in the crypts cheesy

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material or even liquid pus, there were also a few cases which did not show any of these features, and yet were proved to contain infection of definite pathogenic importance.

There are many possible fallacies, and probably the most misleading type is one which either from trauma of incomplete operations, or from intense inflammations many years before, presents at the time of examination a firm scar, covering and burying the tonsil remnants and causing perhaps the greatest relative degree of toxæmia.

It was established beyond doubt that hypertrophy is by no means a measure of infectivity, many of the most virulent infections being present in very small shrunken tonsils. In these cases the active tissues of the gland had been replaced by fibrous tissue laid down during repeated attacks of inflammation, and the tonsil was reduced to a fibrous mass, often very adherent to the surrounding tissues and containing in its substance tortuous crypts which could only act as reservoirs of septic material. In this respect it is interesting to note that the consensus of opinion at a meeting of the Laryngological Section of the Royal Society of Medicine on November 5, 1920, was that although the size of the tonsil is no guide as to its infectivity, the most chronic infections, and especially evidence of tuberculosis, were found in association with shrunken tonsils.

Projection of the tonsils into the pharynx is not a reliable indication of the amount of hypertrophy, for one frequently sees tonsils which at first glance appear flat, yet on contraction of the pharyngeal constrictors reveal large masses buried under the fauces and soft palate. This, of course, is an anatomical accident dependent upon the area of attachment of the tonsil and the development of the plica triangularis, which will be referred to later.

The history of the patient is not always helpful in deciding the question of culpability of the tonsil. Some patients were acutely aware of their throat infections, others resented the suggestion that there was any blame to be attached to their tonsils, which had never given them any trouble, while an important class gave a history of attacks of tonsillitis in childhood, but were definite that for many years there had been no recurrence.

The presence of enlarged glands in the anterior triangle in adults is important evidence of infection.

Bacteriological findings from swabs taken from the tonsils before removal are of no value except in cases where the crypts are very widely opened, and samples of the bacterial contents of the deepest parts can be obtained, for Gardiner¹ has proved

that the pathogenic infections are to be found in the deep part of the crypts.

The amount of visible infection bore no constant relationship to the symptoms produced, and it became evident that, given any degree of infection, the relative immunity of the patient varies abruptly from time to time. The best example of this is the case of A. B., who suffered from recurrent attacks of urticaria, which had no obvious relation to changes in the throat condition, but which were cured by complete enucleation. Dr. J. A. Ryle examined in the post-mortem room the tonsils of many patients dying from various causes, and found that the great majority contained liquid pus in appreciable quantities, this being due to a terminal lowering of resistance.

In order, therefore, to make a decision on the possible effects of tonsil infection, it is necessary to examine them with these facts in view, and to correlate all the available evidence. In many of these cases the association of other conditions generally accepted to be caused by chronic sepsis, such as rheumatoid arthritis, gave valuable additional evidence.

(b) THE OPERATION OF CHOICE

It is submitted that it is absolutely essential to perform the most complete enucleation possible in these cases, and that to accomplish this no form of operation, except a deliberate dissection, is efficient.

From the clinical point of view Dr. A. P. Beddard and Dr. H. W. Barber have frequently insisted that recurrences follow any procedure which leaves any trace of the infected tissues, but no case is so lucid in this respect as a case of lupus erythematosus published by Barber,² in which recurrent infections took place in small tonsil remnants and were accompanied by marked exacerbations on the face, which cleared up entirely on completing the operation.

In spite of accumulating evidence there is still a section of opinion which deprecates any extensive and prolonged dissection operation. It is held by some that the desired result can be obtained by the use of one of the many forms of guillotines, hæmostatic or otherwise, which have been devised to meet the exigencies of out-patient practice. While these instruments serve admirably for the purpose of removing neatly and rapidly large numbers of tonsils, a consideration of some pathological and anatomical facts makes it clear that they are in no case sufficient for the total eradication of lymphoid-tissue necessary if the remote effects of absorption are to be removed permanently.

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The pathological condition present is that of generalised inflammatory adhesions of the tonsil to the pillars and pharyngeal wall; this effectually prevents the use of the guillotine, which is dependent upon the dislocation of the tonsil into the ring of the instrument.

The anatomical factors referred to are the plica triangularis, the lingual prolongation, and the supra-tonsillar fossa.

The plica triangularis is a band of fibrous tissue, attached above to the upper and anterior part of the posterior fold, anteriorly to the anterior fold, and below to the pharyngeal mucosa close to the tongue and following closely the lower attachment of the tonsil. This fold plays an important part in

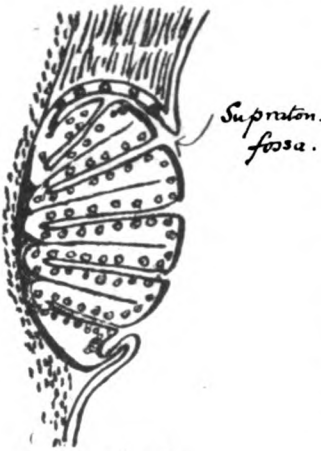


FIG. 1.

Vertical section through tonsil showing supra-tonsillar fossa.

(H. Barnes, Harvard.)

development, and at an early stage, owing to the oblique disposition of the tonsillar sinus due to the tendency to ventrodorsal direction of the posterior fold and relatively dorsal position of the tongue, the lower end of the plica forms a kind of sling for the developing tonsil and narrows the pharyngeal opening of the sinus. Later the relative displacement ventralwards of the tongue and the separation of the folds by the growth of the tonsil tend to push the plica into a less oblique position. In certain cases a persistence of the original disposition of the plica prevents the tonsil from projecting and results in the buried form of tonsil, which forms a formidable obstacle to the use of

the guillotine. Further, this fold may be either attached to the adjacent surface of the tonsil by adhesions, or may have upon its deep surface a mass more or less extensive of lymphoid tissue separate from the tonsil, which may remain as a focus of infection.

The lingual prolongation of the tonsil is an elongated mass of lymphoid tissue, which forms the part of Waldeyer's ring between the faucial and lingual tonsils. It is in many cases present in considerable size, and is invariably left intact by the cleanest of guillotine removals, and such cases very commonly need a second operation for the removal of the hypertrophied masses.

Although the lymphoid tissue lining the supra-tonsillar fossa (Fig. 1) may be to a large extent removed by a very complete inversion of the tonsil in the guillotine method, there

is a probability that some may be left, and some cases showed that if this is the case the remnants are buried under the scar and expand into the substance of the soft palate, making dissection difficult.

Objections to total enucleation are forthcoming also on the grounds that the tonsil has certain functions and ought to be preserved. While it is probable that there is some foundation in ascribing to the healthy tonsil the functions of lymphocyte formation, internal secretion, elimination, etc., the results in the cases treated show that in the case of diseased tonsils these functions are negligible, and in actual fact no one has succeeded in proving the tonsil to be different from any other lymph node.

The fact that in Dr. Barber's cases it was necessary to prepare a vaccine from the tonsil led me to adopt a technique which would be suitable to the bacteriological requirements and applicable to patients who often showed evidences of intense toxæmia. The condition of many of these patients demanded that they should be spared as far as possible from doses of toxic drugs, such as chloroform or morphia, and especially that there should be no risk of congestion, which is the most fruitful source of hæmorrhage, cardiac dilatation and

fatigue of the patient. The subject of anæsthesia in these cases has always been one around which a great deal of discussion has taken place. At a joint meeting of the Anæsthetic and Laryngological Sections of the Royal Society of Medicine in February 1920, it was agreed that ether is the anæsthetic of choice, and my cases have borne this out. The difficulty is, of course, created by the nearness of the bleeding point of the larynx. It appeared that the whole problem might be solved by adopting a method of efficient removal of the blood at the moment it is shed. This is accomplished by the use of Yankauer's apparatus, a portable machine consisting of an electrically-driven pump, which, by working a double piston connected to two air-tight bottles, produces in one bottle a negative and in the other a positive pressure, thus providing an anæsthetic insufflator and an efficient blood evacuator. Fig. 2 is an illustration of the apparatus, and experience of a great number of cases has proved that it has

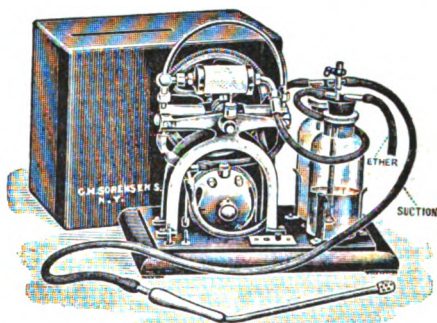


FIG. 2.

Yankauer's apparatus.

the great advantages of removing the blood efficiently without in any way stimulating the pharyngeal muscles to contract, as is the case in every form of sponging, and of providing a perfectly clear view of the parts, and securing, by prevention of congestion, the opportunity of a leisurely performance of any pharyngeal operation, a point of the greatest importance. The method is applicable in cases where the condition of the patient is bad and has been used with marked success in cases of pericarditis, exophthalmic goitre and many conditions of intense toxæmia.

It seemed necessary to modify the ordinary methods of procedure in the actual dissection of the tonsil in order to get the best bacteriological results. All methods of enucleation in vogue now involve the seizing of the tonsil by vulsellum forceps,



FIG. 3.
The tonsil hook.

which frequently bite through the substance of the gland and always crush the tonsil a great deal, thus bringing about considerable alteration in the distribution of the bacterial contents and to a great degree invalidating the results of examination.

In order to avoid this and also to enable the buried and cicatricial type of tonsil to be exposed easily, a modification of Boethcher's hook was made for me by Messrs. Down Bros., by means of which the most contracted type of tonsil can be easily dissected and delivered in a condition approximating as nearly as possible to that which exists before removal, the tonsil being impaled along its deeper planes (Fig. 3). All finger dissection was avoided by the use of a special dissecting knife, and excessive hæmorrhage prevented by completing the last steps of the operation with a snare after the pattern of Eve's.

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DIAGNOSIS OF ACUTE MASTOIDITIS

By W. M. MOLLISON, C.B.E., M.Ch., Surgeon in Charge of Throat and Ear Department, Guy's Hospital.

EVERY case of acute suppurative otitis media must be looked upon as one of potential acute mastoiditis. It is scarcely putting it too strongly to say that the generally accepted idea of acute mastoiditis is that of an advanced mastoiditis: that there should be a red, tender, fluctuating swelling over the mastoid, causing displacement of the auricle forwards and downwards; this is fostered by textbook descriptions and illustrations. These notes are intended to dispel this idea and to urge the importance of early diagnosis before suppuration in the mastoid reaches the surface, producing the condition figured in most text-books. It is highly probable that in all cases of acute otitis media inflammation affects the lining of the antrum. This may progress to suppuration in the antrum and thence to the mastoid cells.

The outcome of acute inflammation in the mastoid process varies according to the degree of infection, the resistance of the patient, and the anatomical conditions in the bone. When suppuration follows it spreads in various directions and may eventually cause periostitis or subperiosteal abscess which points over the mastoid or in the external auditory meatus; when suppuration reaches the dura mater of the posterior or middle fossa further complications may occur—extradural abscess, lateral sinus thrombosis, subdural abscess, and cerebral or cerebellar abscess. Though all these conditions can be relieved by operation, there is a risk to life if operation is not performed early in the disease. Perhaps more important is the question of hearing, and from this point of view early diagnosis of acute mastoiditis and subsequent early operation are essential. Suppuration in the antrum and mastoid cells causes continued inflammation of the middle ear. The middle ear is a small space containing the ossicles and lined everywhere by mucous membrane; swelling of the mucous membrane and exudation from it, with consequent limitation of movement of the ossicles and tendency to the formation of adhesions, result is deafness. Hence the reason for early drainage of the mastoid and antrum

to allow the middle-ear inflammation to resolve. There is, it is true, another factor in the causation of deafness—reinfection of the middle ear from the nasopharynx *via* the Eustachian tube, but this can be treated and forms a separate subject.

In the majority of cases mastoiditis is preceded by acute suppurative otitis media, perforation of the membrane and discharge of pus through the meatus. Cases do occur where perforation of the membrane does not follow the middle-ear inflammation; diagnosis of early acute mastoiditis is then always more difficult and indeed may not be made till some complication has arisen which places the patient's life in jeopardy. Acute mastoiditis also occurs in the course of chronic middle-ear suppuration, but these cases will not be included in this paper.

Consider first cases of acute otitis media with discharge of pus through a perforation. The possibility of acute mastoiditis must always be remembered. One symptom or sign alone will not lead to a diagnosis, but a combination of two or three will be of great help.

(1) *The History*.—If the patient has had scarlet fever, measles, or influenza, especially the two latter, mastoiditis is likely. The more acute the onset the more likely is the mastoid to become involved. Cases are known where an acute otitis media came on so acutely that within twenty-four hours the mastoid has contained much pus. The membrane may perforate so soon after the initial pain that there is no time for incision of the membrane. Again otorrhœa may be the first sign of any ear infection. Cases have been observed in which pus is found coming from the ear in the morning, though the child went to bed the previous evening apparently perfectly well; one such case that came under my observation passed on to acute mastoiditis. Should incision of the membrane be undertaken for the relief of acute otitis media, the fact of finding pus escape under much pressure with bubbles of gas should make one suspicious of the possibility of mastoiditis following.

(2) *Pain*.—Pain is a very variable factor; it is quite possible to find acute mastoiditis though the patient complains of no pain; this applies both to children and adults, though it is commoner in children. On the other hand, pain may be most severe both in the ear and over the mastoid process from the very beginning of the disease; particularly is this the case when the bone is of the diploët type and contains no cells. Continued pain is a symptom very suggestive of mastoid involvement.

Pain is always difficult to assess correctly. Children will say they have no pain in order to avoid possible unpleasant consequences. Adults, especially men, will deny that they have pain simply because they do not look upon the ache in the ear as worthy of the name of pain. An aid to deciding about pain is to ask about the patient's sleep. If sleep is disturbed by pain, it must be considerable. Pain is not always continuous, but may come on in attacks lasting perhaps half an hour to three hours and followed by a quiescent period.

To sum up, pain severe and continuous over two or three days is suggestive of mastoid involvement, but absence of pain does not exclude it. The pain of uncomplicated acute otitis media after the membrane has been incised or has perforated ought to diminish rapidly and disappear completely in forty-eight hours.

(3) *Otorrhœa*.—Discharge from the ear is present in the cases under consideration; it is odourless and at first thin and blood-stained; later it becomes thicker and cream-coloured. In a few days the discharge diminishes, and at the end of ten days or a fortnight it ceases. Continuance of a profuse, creamy discharge is very suggestive of involvement of the mastoid antrum and cells. It is difficult to estimate the amount of otorrhœa, but if wool placed in the ear requires changing every two hours there is more pus than can be accounted for by a simple otitis media. If, after wiping away the pus in the meatus, more pus is seen welling out through the perforation in the membrane, mastoiditis must be suspected. Sometimes the discharge remains thin instead of becoming creamy; if this discharge is profuse and tends to make the meatal wall and concha excoriated, mastoiditis is probable. To sum up, profuse, creamy otorrhœa, continuing for more than three or four days after the perforation of the membrane is very suggestive of acute mastoiditis; if it is accompanied by pain the suspicion is greater. Cessation of otorrhœa does not often occur in acute mastoiditis unless this complication has arisen in the course of chronic middle-ear suppuration.

(4) *General Condition of the Patient*.—At the onset of acute otitis the patient suffers from malaise and loss of appetite as in any other septic infection: the temperature is often as high as 102° to 104° F. in young children and the face is flushed. As soon as otorrhœa is established the temperature falls and the patient feels comparatively well. If mastoiditis supervenes the temperature does not fall to normal, the pulse remains quicker than normal, and the general malaise persists; the face is often pale and the patient has a "toxic" appearance. These

symptoms, coupled with continued profuse discharge and pain in and behind the ear, greatly assist in the diagnosis. Typically acute mastoiditis is accompanied by a swinging temperature—in the morning 97° to 98° F., and in the evening 99.5° to 100° F.; indeed a swinging temperature, combined with the signs already mentioned, is of great assistance in fixing the diagnosis. In uncomplicated acute mastoiditis the temperature is very seldom raised above 100° F. Should it remain at 102° or 103° at the end of the fourth or fifth day of an acute otitis media with free discharge of pus, some complication, such as extradural abscess, must be suspected and operation undertaken. In a small proportion of cases the temperature may be normal or within half a degree of normal, and yet on operation the pus may pour out at the first cut with the gouge. Patients may protest they feel quite well, even though for other reasons mastoid involvement is suspected; at the same time they may confess that they prefer staying in bed or that if they get up they very soon feel tired and are glad to lie down again. I have seen one case where this was the only symptom that anything was wrong beyond a continued discharge of thin pus from the ear, and yet on operation the whole mastoid process was full of pus; in that case, too, the temperature was normal for three days before operation.

There are cases where patients are so well that they get up and about as usual; in a man of fifty-three otorrhœa had persisted for eight weeks and operation showed extensive suppuration in the mastoid, yet the patient felt well, travelled up and down twice from Margate to London and transacted business. To sum up, malaise, headache and persistent evening rise of temperature in conjunction with continued otorrhœa point to mastoid involvement, but the malaise may be of very slight degree and the temperature can be normal.

(5) *Signs about the Mastoid Process.*—In an advanced case of acute mastoiditis swelling of the tissues over the process and tenderness, especially on deep pressure, displacement of the pinna and redness of the skin make diagnosis obvious. The stage at which signs of suppuration in the mastoid appear is variable; sometimes there is not twenty-four hours between the onset of acute otitis media and the appearance of typical tenderness over the mastoid process; at other times the onset of the mastoid signs may be delayed two or three weeks. To wait for this clinical picture is to fail in early diagnosis. Every case of acute suppurative otitis media must be under suspicion of passing on to acute mastoiditis. Tenderness must be sought in every case. Generally before the membrane perforates or

is incised some tenderness is present over the upper part of the mastoid; after otorrhœa is established tenderness should diminish soon and disappear in twenty-four to forty-eight hours. Persistence of tenderness in the presence of profuse otorrhœa is diagnostic of mastoiditis. Tenderness is not, however, always obvious by any means; it must be sought in all parts of the mastoid process, especially in three positions: (a) over Macewen's triangle—the surface marking of the antrum, (b) the tip of the mastoid, and (c) behind the mastoid.

(a) Firm pressure over Macewen's triangle will in most cases of acute mastoiditis cause pain, but in children a confession of tenderness is often withheld for fear of something having to be done; one has to rely therefore in doubtful cases on close observation of the face and eye for any sign of flinching, or simultaneous pressure of both mastoids will perhaps result in the patient confessing that pressure is greater on the suspected side.

(b) The tip may be the only tender spot; this depends on the presence of superficial cells in the tip, often larger and more superficial than in other parts. Should tenderness be combined with infiltration of the tissues and obscuration of the tip, suppuration is almost certain.

(c) Tenderness behind the mastoid is inconstant, but when definite is a confirmatory sign of suppuration. Its presence is due to cells extending backwards in the region of the lateral sinus; cells are often found superficial to the sinus and even posterior to it: when these cells contain pus, pressure over them is the cause of the tenderness. It is sometimes taught that tenderness on pressure behind the mastoid process indicated a perisinous abscess, but that is not so though tenderness may accompany it.

The next important sign is thickening or infiltration of the tissues about the mastoid: "about" is used designedly, as every side must be examined and not only the surface. The infiltration is due to spread of infection through the bone to the periosteum; it is the first stage of a suppurative periostitis. There are three chief areas to be examined for infiltration: (1) the surface of the bone over Macewen's triangle; only by careful comparison of the two sides will slight degree of infiltration be discovered, but even a slight degree in the presence of tenderness is strong evidence of infection in the bone; (2) thickening of the tissues over the tip of the mastoid has already been mentioned; cells often extend to the tip of the mastoid and periostitis over them causes infiltration. To observe the thickening here compare the two mastoids, placing

a finger underneath the tip; on the affected side the finger cannot feel the outline as on the normal side; (3) the anterior surface of the mastoid process is the posterior wall of the bony external auditory meatus, and it is just as important to look for infiltration here as over Macewen's triangle. The infiltration shows itself as a reddened swelling of the deep meatal wall and of the posterior superior part; the swelling is sometimes slight, but may be so marked as to overshadow the membrane. The presence of otorrhœa and swelling of the deep meatal wall are diagnostic of mastoiditis.

Swelling of the meatal wall suggests a boil in the meatus, but boils only occur in the outer two-thirds of the meatus, so that the deep swelling should not be confused with a boil. Though mastoiditis gives rise to swelling of the deep meatus as a rule, it can and does in a small percentage of cases give rise to swelling in the superficial meatus; in that case the resemblance to a boil is exact, and diagnosis between them is difficult. Œdema is rarely seen in cases of acute mastoiditis. Indeed, should there be a swelling over the mastoid which pits on pressure, mastoiditis is unlikely, and a lymphangitis from a meatal boil is almost certain. In a case of acute mastoiditis increasing pressure applied by one finger is more and more resented; in lymphangitis increasing pressure is less and less resented, till the bone may be pressed upon quite firmly without any complaint from the patient.

There is one other group of cases, where swelling occurs in front and above the pinna: this is due to suppuration in the cells at the root of the zygoma. This swelling may be in addition to swelling over the mastoid, or it may be the only outward sign of suppuration; the swelling may spread forwards into the temporal fossa, filling it completely. Lastly, in Bezold's mastoiditis suppuration extends through the bone deeply and appears on the inner surface of the mastoid—*i. e.* in the digastric fossa: thence the inflammation passes down into the neck and appears below the tip of the process; a swelling is thus formed in the neck.

There are cases of acute otitis media which pass over to mastoiditis without any otorrhœa; inflammation occurs in the middle ear and passes to the antrum and thence to the mastoid cells; in the meantime the middle-ear inflammation resolves, but never completely. Examination of the membrane shows it duller and probably pinker than that of the other ear. But more important is the examination of the hearing, the affected ear being always deaf.

Pain behind the ear, with tenderness and swelling over the

mastoid process, combined with deafness, would be strong evidence of mastoiditis. Confirmation of the diagnosis may be obtained by puncture of the membrane; in some cases blood will appear and in others pus, which has never been under sufficient pressure to perforate the membrane.

The following case illustrates the difficulty in diagnosis:—

A boy of nine had an attack of measles. Both ears ached for more than a week, and there was some discharge from the right one. The pain on the left side disappeared, but he remained a little deaf. Three or four weeks later a tender swelling appeared behind the left ear, remained four days and then disappeared. A week later, five weeks after the onset of the ear-ache, the boy was apparently well; both membranes were dull. Hearing in the right ear was good; all tuning-forks except the lowest (16 vibrations per sec.) were heard. The left ear was a little deaf, whispered words being heard at 6 feet instead of the normal 18; the appreciation for low notes was slightly less than the other ear, a tuning-fork of 64 vibrations per sec. being the lowest note heard. There was only the slightest amount of thickening over the left mastoid when compared with the right, and the tip of the process was quite free; there was no tenderness at all. The boy was allowed to go back to school. Six weeks later he was seen again; he had been perfectly well and had played games as usual. Thirty-six hours before examination he had discovered accidentally that he was tender behind the ear again—he had been given instructions to report at once if the ear became painful. There was now slight thickening over the left mastoid process in its upper part only, and tenderness limited to Mac-ewen's triangle. The membrane was dull and bulging posteriorly. Deafness was marked, whispered words being heard only at a distance of six inches. Mastoiditis was diagnosed and operation performed; not only was the whole mastoid process full of pus, but there was a peri-sinous abscess. Incision of the membrane showed blood with only flakes of pus. The boy fortunately made a good recovery and regained normal hearing.

There can be no doubt that this was a case of acute mastoiditis from the first, with very few signs. There never was any perforation of the membrane, but three weeks after the onset there was some swelling over the mastoid with tenderness. It was unusual to find such good hearing and for the boy to be so well that he enjoyed playing games.

CONCLUSIONS

Early diagnosis of acute mastoiditis is important that operation may be performed early to save the hearing. Diagnosis in a case presenting a combination of the symptoms and signs described is easy : thus ; an acute onset, early rupture of the membrane, continued profuse discharge, pain preventing sleep, a swinging temperature, tenderness over the tip of the mastoid and a Macewen's triangle, swelling of the deep meatal wall make a typical picture. When, however, one or two signs only are present diagnosis is far from easy, and a survey of all the features of the case is essential.

Absence of some of the salient features does not exclude extensive suppuration in the mastoid.

EDITORIAL NOTICES

1. Papers for publication and editorial communications should be addressed to Dr. A. F. Hurst, Guy's Hospital, London, S.E.1.

2. Business communications regarding subscriptions, change of address, advertising, etc., should be addressed to Henry Frowde and Hodder & Stoughton, The *Lancet* Building, 1 & 2 Bedford Street, London, W.C.2:

8. The following papers are amongst those which will appear in forthcoming issues of the Reports :

J. Fawcett : Addison and Addison's Anæmia.

G. H. Hunt and M. S. Pembrey : Test of Physical Efficiency.

A. D. Fripp : Internal Derangements of the Knee-Joint.

J. A. Ryle and T. I. Bennett : Further Studies in Gastric Secretion.

H. W. Barber : Pathogenesis of Lupus Erythenatosus.

L. S. Debenham, J. Joffre and M. S. Pembrey : Observations on Secretion of Urine in a case of Ectopic Vesicæ.

Discussion on Rheumatoid Arthritis by various authors.

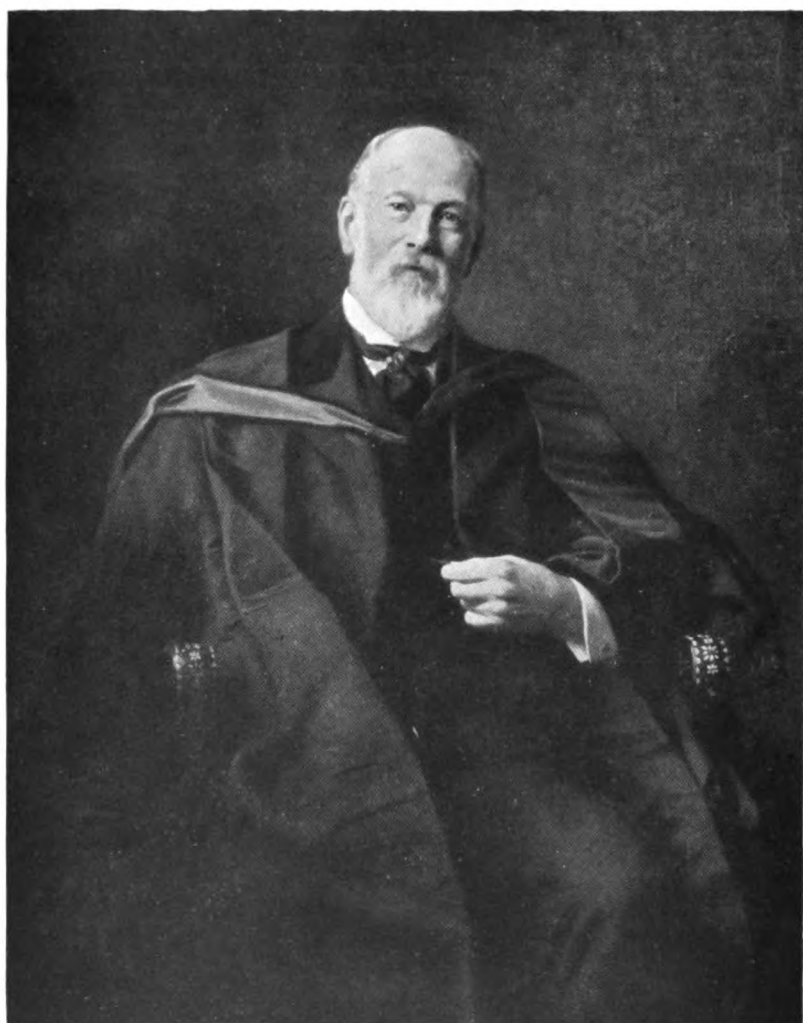
P. Turner: Note on the Measurement of Shortening after Fractures of the Lower Extremity.

E. P. Poulton and G. B. Dowling : Study of a Case of Sino-auricular Depression (S. A. Heart-Block) and its bearing on the Genesis of the Heart-beat.

4. Readers are invited to send for publication short communications or criticisms on papers appearing in the Reports. These will be submitted to the writer of the original paper, so that he may reply in the same issue of the Reports.

5. Authors are allowed fifty reprints of their papers gratuitously. Additional copies may be had at cost price.

6. Owing to the extreme indefiniteness of what can be regarded as the termination of the War, and the consequent difficulty of deciding just when the records of the doings of Guy's men in the War can be regarded as final and complete, the issue of the last volume of the old series of Guy's Hospital Reports in the form of a War Memorial Volume has been unavoidably delayed.



PHILIP HENRY PYE-SMITH, M.D., F.R.C.P., F.R.S.
BORN 1840—DIED 1914.

IN MEMORIAM: PHILIP HENRY PYE-SMITH

By G. NEWTON PITT, M.D., Consulting Physician to Guy's Hospital.

DR. EBENEZER PYE-SMITH, Philip Pye-Smith's father, was born in 1817, and entered Guy's Hospital, where he followed the teaching of Astley Cooper, Bright, and Addison, and dressed for Aston Key. John Hilton and Thomas Hodgkin were his intimate friends, and he took an active part in the protest against the exclusion of Hodgkin from the Guy's Hospital Staff. He was an exceptionally able man, and four of his pupils ultimately became physicians on the Staff of Guy's Hospital, viz., Habershon, Pavy, J. J. Phillips and his own son, a record which was probably unequalled by that of any other practitioner.

Philip Pye-Smith, who was his eldest son, was educated at Mill Hill School and went to University College, taking the degree of B.A. London in classics with honours in 1858. He entered at Guy's Hospital in 1859. In 1861 he took the exhibition and gold medal in physiology, histology and comparative anatomy, and honours in anatomy, organic chemistry and materia medica, and in 1863 he took the gold medals in medicine and surgery, with first-class honours in obstetric medicine, and honours in forensic medicine. He took the gold medal for the M.D. in 1864. It is doubtful whether any one ever carried off more honours at the University; his success was due to his great accuracy and method of thought combined with great industry.

He had visited Germany as a boy and spoke the language fluently; he was complimented on the accuracy and elegance of his French, and in after years he could read both Italian and Spanish. After qualifying he spent some time at Edinburgh, and studied in the wards of the Royal Infirmary under Dr. Hughes Bennett, when Dyce Duckworth was his house physician. A visit to the medical schools of Berlin, Vienna, and Paris followed, and this enabled him to form lasting friendships with Trousseau, Virchow, Ludwig, and Hebra. While in Vienna he lived with Professor Hebra, and thus early became interested in dermatology. On his return in 1878 he was appointed lecturer on comparative anatomy and zoology at

Guy's. He held this appointment for ten years, and he always maintained his connection with the Zoological Society and became much interested in natural history.

In 1870 he was appointed medical registrar, and in 1871 assistant physician; in 1878 he was appointed joint lecturer with Dr. Pavy on physiology, and was the sole lecturer from 1877 to 1884. At that time there was but very little practical work beyond certain chemical reactions for the students in physiology, but Pye-Smith's lectures were well delivered, illustrated by numerous carefully-drawn diagrams and elaborate tables, and presented always a full and up-to-date account of the current views on the subject. Many years later, when the anti-vivisection agitation arose, the meetings for the organisation of the defence of vivisection used to be held at Dr. Pye-Smith's house.

His chief interest in medicine was in diseases of the skin, the clinic of which he held for many years and which he made very popular, and patients with skin diseases constituted the major part of his private practice. The subject was especially adapted to his precise and didactic teaching. The nomenclature of skin diseases at that time was most chaotic: he insisted on an accurate terminology for each lesion founded on a careful determination of its cause, and he constantly denounced the French School with its diatheses. His *Introduction to Skin Diseases*, published in 1893, was of great value in improving the nomenclature: such a term as syphilitic psoriasis was anathema to him. At the same time he was in many ways very conservative, and did not readily accept the advances in local treatment and in our knowledge which were being published at other schools.

On the death of Hilton Fagge he became full physician, and in 1890 senior physician to the Hospital, finally becoming consulting physician in 1887. He succeeded Moxon as lecturer on medicine in 1884.

Spare in figure, neat and exact in his dress, with a pleasant, well-modulated voice, his lectures were always carefully prepared and delivered in well-chosen words. They were founded on a careful study of the subject, and the information was always methodically and systematically arranged.

Pye-Smith became a Fellow of the Royal College of Physicians in 1870; he was an examiner for eight years, a Member of Council from 1888 to 1890, and a Censor from 1894 to 1899. He gave the Lumleian Lectures on "The Etiology of Disease" in 1892, and a very scholarly Harveian oration on "Pathology as the Basis of Rational Medicine" in 1893.

He took great interest in the affairs of the College, and was a regular attendant at the meetings of the Comitia. He was the representative of the College on the Senate of the University of London from 1902 to 1908, and was Vice-Chancellor from 1908 to 1905. As a member of Convocation and of the Senate he took an active part in the discussions on the reform of the University. He always advocated a sound knowledge of science and physiology as the basis of medical education, and did much to establish the high standard required by the University. He was a member and treasurer of the General Medical Council for many years. Perfect honesty of purpose, precision of argument and readiness to attack any pretentious claim or false argument gave value to his opinion in debates.

In 1878 he was vice-president of the Physiological Section of the British Medical Association at Bath; in 1891 he was president of the Section of Medicine at Bournemouth, and in 1900 he gave the address on "Medicine as a Science and Medicine as an Art" at Ipswich. In 1886 he was elected a Fellow of the Royal Society, and was on the Council in 1891-2. With Sir Herbert Maxwell he represented the British Government at the International Congress on the "Prevention of Tuberculosis" in Berlin in 1899. He received honorary degrees from the Universities of Berlin, Paris, and Dublin, and was an Honorary Fellow of the Royal College of Physicians of Philadelphia.

His great delight was the constant companionship of old and standard authors. He daily read his classics and old English authors and had a wide acquaintance with standard literature.

His interest in the history of medicine was great, and he was constantly bringing before his students the names of old physicians, and indicating how and by whom our knowledge of disease had been increased. He used to recommend that they should read Sydenham and Heberden as well as the current books. When Hilton Fagge died in 1888 his work on the "Principles and Practice of Medicine" was unfinished, and Pye-Smith helped to edit the book. He also brought out the three later editions. He prefaced each chapter with an appropriate quotation from the classics and added a short sketch of how our knowledge had been acquired, thus greatly increasing the interest of the book. He not only contributed the whole of the articles on cutaneous diseases, but added in the later editions a large amount of statistical information with regard to certain diseases which Fagge had not supplied, so that the work will always remain of great value.

His success as a clinical teacher was chiefly with the junior students, whom he drilled in the systematic and thorough examination of their patients. Students were advised to acquire familiarity with the physical signs on themselves, taking the right axilla for pulmonary resonance, the abdomen for the tympanitic note and the thigh for dullness; to recall their own anatomy and from their own illnesses and accidents to learn to sympathise with pain, to tolerate impatience, and to put themselves in their patient's place.

He required a definite diagnosis to be made of each obvious lesion, more or less complete, according to one's knowledge, *e. g.* morbus cordis—hypertrophied heart—aortic incompetence. This was most excellent training and cultivated method and definiteness. But this same precision and simplification, which would not recognise uncertainty, often caused the difficulties and obscurities of a case to be overlooked, so that, owing to a lack of that clinical instinct which was so striking a gift in Gull, Fagge, and Moxon, he did not attain the eminence that they did in training senior students. Among his many aphorisms we may note the following :—

The loudness of a bruit is unimportant; its rhythm and distribution are all-important.

It is a venial error to overlook a bruit, but a grave one to imagine one when it does not exist.

Persevere in treatment, and push the dose of your drugs.

Depend upon a patient's own statement of his ailments rather than on those of his wife or her sister.

Bronchitis often means consumption; pain in the chest stomach-ache; sunstroke syphilis; gout a degenerative arthritis; neuralgia toothache; rheumatism myalgia; overwork over-eating; mental worry dram-drinking.

Think of pregnancy in cases of abdominal tumour in women, and of irritant poisoning in cases of obscure vomiting.

Study especially the usual distribution of a disease in the body, and when a lymphatic gland is enlarged, locate the primary seat of infection.

Be sympathetic, and never give a minute diagnosis to the patient himself.

His dislike to newspapers was so marked that for many years he refused to take in any daily paper. He constantly impressed upon students that while they would have spare time for general reading, if they would only have the resolution to give up the morning newspapers, they would find how much

happier they would be without them, and how much more amusement they would get from Addison or Goldsmith or Lamb than from the *Daily Chronicle*. He urged students while they were at the hospital to take up some form of exercise. He himself used to take riding tours, and knew Yorkshire, the Lakes, Warwickshire, Oxfordshire, and Sussex well from having ridden through them. He was also fond of rowing, walking and climbing.

One piece of advice that he gave was that if students found themselves unable to reconcile their observation of facts with the traditional records of religion, they should not trouble themselves, but remember that the greatest names in science, such as Newton, Leibnitz, and Faraday, never interested themselves in trying to solve questions which were probably insoluble.

So great was his dislike of any bombast or self-glorification, that he went so far at one time as to write a pamphlet as a sequel to the history of Sir Charles Grandison by Richardson. He tried to show that any one who boasted as much as Sir Charles should be suspected of villany. He especially excelled as an after-dinner speaker or when called upon to carry out any public function, notably when, as Vice-Chancellor of the University of London, he introduced the then Prince and Princess of Wales to the Chancellor for the conferment of their honorary degrees in the happiest and most graceful terms.

In 1894 he married Gertrude, the daughter of Mr. Arthur Foulger, of Chigwell, and by his marriage appreciably enlarged his outlook on life. He was surrounded by a large circle of intimate friends, whom he delighted to entertain, and many happy years followed. During these years he led a very busy life and held many important offices, in the discharge of which duties he never spared himself, but always conscientiously attended meetings and took an active and important part in all discussions. He never would allow any statement he considered erroneous or unfair to pass unchallenged.

Some eight or ten years before his death slight symptoms of paralysis agitans presented themselves, and the fell disease slowly progressed, increasingly crippling him. He died on May 28, 1914.

His only son, Philip Howson Guy, was born in 1896 and was educated at Eton and Magdalen College, Oxford, and had before him the promise of a brilliant career. When the war broke out, he joined as a Cadet and received a commission in the 11th Pioneers of the King's Own Liverpool Rifles, with which he served in France. He was wounded in 1916, and died in action

on June 5, 1917. He had written the following verses at the time of his father's death—

Scholar, Physician, courteous gentleman,
beloved of all that knew him, and the pride
of all that called him friend : and yet how small
seem honours, learning, eminence and skill,
when stood before the eternal might of God.
“What in this life of ours is truly great
or wonderful? So weak are we and poor.”
So spake the pessimist full earnestly.
Then would we answer make : “He lived his life
that other men might see, and seeing, strive
like him to live more closely after Christ.”

BRIGHT'S OBSERVATIONS OTHER THAN THOSE ON RENAL DISEASE

By SIR WILLIAM HALE-WHITE, K.B.E., M.D., Consulting Physician
to Guy's Hospital.

IN the last number of the *Guy's Hospital Reports* I gave a description of the discovery of Bright's disease and a short account of Bright himself. Here my desire is to indicate some other of his observations, and in order to do so I have read everything he published. It is quite likely that some of them are lost to us, for we have no record of his Lumleian Lectures, nor of his contributions to the Physical Society, nor of his oral teaching. In what follows, allusion is only made to those papers in which he records observations which were not at his time generally known; many of them were undoubtedly original, how many could not be determined without a searching of the older medical literature, which would take at least years, but as far as Bright is concerned they were original, for he is careful to give credit to workers who have preceded him. It has been truly said that for one person who can see, fifty can think. Bright's power of seeing was extraordinary, little escaped him, but he never saw what was not there, not a single one of his observations has been shown to be incorrect. His accuracy and truthfulness are wonderful; no preconceived idea ever tints his descriptions. Readers of his works must also be struck with his unflagging industry. He considers no trouble too great to obtain a post-mortem examination, to do which he will willingly go into the country—and it was slow travelling then—in order that he may be present. Lastly, his natural bent and training gave him the ability to write well. It is a pleasure to read him; the disease stands out with all its features clear, and the account he gives is as true to-day as it was then. Many times have I thought how much better it would have been if some modern authors, instead of writing their picture of a disease, had transcribed Bright's words.

His principal observations concern spastic paraplegia, epilepsy, localisation of cerebral functions, aphasia, the relationships of chorea, hydatids, fatty stools in diseases of the

pancreas, glycosuria and pancreatic disease, cirrhosis of the liver, acute yellow atrophy of the liver, diaphragmatic hernia, chronic peritonitis, Addison's disease, appendicitis, the administration of oxygen, heart block, and the lungs in whooping cough.

DISEASES OF THE NERVOUS SYSTEM

The large second volume of *Medical Cases*, with its 724 pages and 40 beautifully coloured plates, is dedicated to James Frank, M.D., F.R.S. After the preface there follow some general remarks among which we find Bright, when mentioning diseases called functional, saying: "This view has often been the unintentional cloak for ignorance and has materially retarded investigation." Several cases are given to illustrate that disease of the ear and nose and bones in their neighbourhood may cause suppurative meningitis, cerebral abscess or thrombosis of sinuses, and it is recognised that a blow may be the starting-point of an acute hydrocephalus or, as we call it nowadays, tuberculous meningitis. In Cases 19 and 21, it was noticed, during life, that the limbs were stiff and that after death in Case 21 "the spine," by which Bright means the spinal cord, was "remarkably firm throughout almost like cartilage." He says: "It appears probable that this condition of the cord was chiefly instrumental in producing" what he calls "the peculiar spasmodic extension of the limbs." The patients each had a tumour of the brain and, no doubt, what we know now to be secondary descending degeneration of the cord, and to Bright must be given the credit of observing that this condition of the cord is associated with spastic paraplegia.

In Case 87 Bright observed and noted hemiopia in cerebral hæmorrhage. On pages 383, 421 and 423 we find recorded three cases of the formation of bullæ on the legs in paraplegia, and he remarks: "It has sometimes struck me that this connection between interrupted nervous action and the formation of bullæ, might hereafter be found to throw light on the nature of that most singular disease 'Herpes Zoster.'"

Case 128 is an instance of meningeal hæmorrhage due to rupture of a small aneurysm. Bright did not recognise that this was embolic, but he believed that the infarct in the spleen probably arose from "a previous effusion of blood."

More than forty examples of cerebral hæmorrhage are given, the loss of sensation and motion is described. In one which puzzled Bright very much the hemiplegia was on the same side as the lesion. One plate illustrates atheroma of the cerebral

arteries and the importance of this as a cause of cerebral hæmorrhage is recognised, and also the relation of this to renal and cardiac disease. There is an admirable survey of the whole subject, and it is pointed out that cerebral hæmorrhage is commonest in males, chiefly over forty, often over fifty years of age, and that frequently there are subordinate seizures before that which is final. The serious nature of renal disease, he says, is often overlooked and before any operation is undertaken the urine should be tested for albumen. There is an account, with excellent plates, of the celebrated case of enormous hydrocephalus in a man named Cardinal, whose skeleton is in Guy's Hospital Museum. The hydrocephalic fluid was analysed by Dr. Bostock, who found it contained urea.

Among the epileptic cases Number 256, that of a man who "wandered about the streets without hat or coat, walking in a state of complete unconsciousness from Clapham Common to Shoreditch and was between four and five hours on the road," shows that Bright recognised epileptic somnambulism, and the next two cases are good instances of epileptic mania. He was insistent that certain epileptic seizures, or as we should now call them, attacks of Jacksonian epilepsy, are due to organic disease of the brain, and he showed how to tell such attacks from ordinary epilepsy. In his *Reports of Medical Cases*, Vol. II. p. 514, he says: "As far as I have been able to infer from my own observation, I should say that the organic causes of epilepsy, connected immediately with the brain, are more frequently such as affect its surface, than such as are deep seated in its substance. Thus we find that morbid growth, taking place in the skull, showing itself by a thickened heavy state of bone, or by a roughened surface either internally or externally, or a remarkable prominence in the natural projections at the base is often associated with epilepsy. Slow changes, producing a thickened condition of the membranes, will not unfrequently be found attendant upon epileptic attacks. Tumours pressing on the surface, or amalgamated with the cineritious substance will also be found in cases of epilepsy." Case 265 is an example in point. A man aged thirty-seven, liable to severe headaches, had fits, ushered in by an aura, which took the form of a tremor and cramp-like sensation in the calf of the right leg which was partially paralysed; in the fits the patient lost consciousness. The aura was so sure a herald of a fit that, when it appeared, a tourniquet "was applied at the lower part of the thigh, with the complete effect, apparently, of putting a stop to the fit." The patient experienced so much relief from the tourniquet that he kept it

"constantly loose on the limb, screwing it tight when he was roused by the painful sensations usually preceding a fit." At the autopsy a tumour was found implicating the left cortex. Case 268 did not die, but it was very similar, and Bright considered that the fits, aura and right-sided paralysis were due to disease in the skull. In Case 271 he diagnoses organic change within the cranium because of the "paralytic condition which remains after the attack and which never entirely subsides." In two other papers we find him maintaining that from the symptoms the situation of lesions in the cerebral nervous system can be foretold. In the first * the author remarks that it is not uncommon to notice that patients in whom the cerebral arteries are probably diseased often complain of a pain "most distinctly referred to that part to which the occipital nerve or a large branch of the second cervical nerve . . . is distributed." Illustrative examples are given, and Bright then says: "What I wish to assert is, that the probability of such a change having taken place in the vessels is considerably increased in each of these cases because the occipital pain has been a prominent symptom; and further that this pain would, of itself, chiefly direct our suspicions to disease of the vertebral arteries." He gives as the explanation the anatomical relationship between "the suboccipital and two superior cervical nerves, relatively to the vertebral artery." Further on he writes "that in those cases where disease of the vessels is attended with unusual symptoms of lethargy, and the superficial pain of the occiput is less observable, it is, in my opinion, probable that the disease has been situated chiefly in the internal carotids and their branches." Cases are produced to illustrate this thesis. In further support of his contention that the situation of disease in the brain can be told from the symptoms he records the case of a man who had right-sided fits. "I now gave it as my opinion that these fits were owing to some local disorganisation affecting the membranes and cineritious portion of the brain on the left side. . . . My reason, then, for supposing that the epileptic attacks, in this case, depended rather on a local affection . . . was the degree of consciousness which was observed to be retained during the fits," and other similar cases are mentioned. Thus we see that Bright was aware of the diagnostic importance of retention of consciousness, but I have already shown that he knew that sometimes consciousness may be lost during fits due to organic disease. The two following quotations from

* "Cases illustrative of the effects produced when the arteries and brain are diseased, selected chiefly with a view to the diagnosis of such affections." *See Hospital Reports*, Vol. I., 1836, p. 9.

the end of this paper may well conclude our reference to it. "In disease, as in other things, cause and effect will be found to follow each other in pretty regular succession." "The epileptic character seemed to point to the membranes and surface of the brain as the parts most affected."

The second paper * continues the same subject. The first two cases in it had many symptoms and were difficult to analyse, but both had a tumour in the cerebellum and both had impairment of taste, which Bright had "no doubt arose from pressure made by the tumour on the fifth pair of nerves," for this was found at the post-mortem examination. Then follow examples of disease of the spinal column, which illustrate how particular symptoms can be precisely explained by pressure on the cord or on the nerves derived from it. After these come two admirably recorded cases of aphasia: the woman "had total inability of connecting her words, when she could utter them, with the ideas she wished to express, or the things to which she meant to refer. . . . When asked, for instance, the name of her hand, to which I pointed, she said 'a pin,' but immediately signified her knowledge that this was not the right word, though she could not tell what the right name was." At the autopsy a cerebral hæmorrhage was found: "its occupying chiefly the posterior part of the corpus striatum is further in accordance with an impression I have received from observation, and inculcated, with regard to the lesions which influence the articulation." The man had a similar form of aphasia: "the great and striking peculiarity was the difficulty of bringing the right words into play, when he spoke." The full description exemplifies this and might be copied into a modern text-book. The last case is that of a man, who during life had deranged sense of touch on the right side together with disorder of vision. The only cerebral abnormality found was an old hæmorrhage in the "posterior part of the right thalamus nervi optici (corpus geniculatum inferius)," and Bright concludes the paper by saying "that the symptoms which arise in cerebral and spinal disease are actually the results . . . of the lesions which the different parts of the nervous system have suffered." These references show that he was one of the earliest enunciators of the doctrine of cerebral localisation.

Bright was emphatic on the association of the various rheumatic affections. In his *Reports of Medical Cases*, Vol. II., Part II., p. 469, he says: "Chorea is associated with amenor-

* "Cases and observations illustrative of diagnosis when tumours are situated at the basis of the brain, or when other parts of the brain and spinal cord suffer lesion from disease." *Guy's Hospital Reports*, Vol. II., 1837, p. 279.

rhœa, with rheumatism, with roseola and with urticaria." He gives illustrative cases, and one of his patients had a sore throat. There is an excellent clinical description of chorea, its relation to mental disorders and its recurrence are observed; he considers that it is often provoked by fright. Frequently it attacks one side of the body more than the other, and "sometimes the loss of power has been such as to imitate hemiplegia." In his fatal case nothing was found in the nervous system to explain the chorea. "We also see that rheumatism is so intimately connected with chorea, that in some cases it seems to have been an exciting cause, at other times to be but a concomitant" which is the state of our knowledge to-day. In 1838, Bright read before the Royal Medical and Chirurgical Society a paper entitled "Cases of Spasmodic Disease accompanying Affections of the Pericardium," the object of which was to show that pericarditis may be accompanied by chorea. He says: "With regard to the connexion between chorea and inflammation of the pericardium, when called upon the year before last to deliver the Lumleian Lectures at the College of Physicians, I took occasion to state, that for some years I had been persuaded of the existence of such a combination, and little attention has hitherto, as far as I know, been paid to the subject, although the combination of this spasmodic disease with rheumatism has long been recognised. In the very excellent *Syllabus or Outlines of Lectures on the Practice of Medicine* published at Guy's Hospital, I find, in the edition of 1802,* rheumatism is distinctly stated as one of the exciting causes of chorea; and in later editions, as in that of 1820, I find it stated that 'chorea sometimes alternates with acute rheumatism.' . . . Having had my attention, all my life, through the lectures of Dr. Babbington, Dr. Curry and Dr. Cholmeley directed occasionally to this subject it has occurred to me to see many cases of the combination . . . and some which have convinced me that amongst the causes of chorea . . . inflammation of the pericardium has been one." In one of his cases he describes endocarditis of the mitral and semilunar valves, and Sir Samuel Wilks believed that Bright was the first person to describe a mitral murmur in chorea. Readers of Osler's book *On Chorea*, published in 1894, will, after comparing the dates of the early writers, come to the conclusion that it was at Guy's Hospital that the association between chorea and rheumatism was first taught. Bright did much to make

* *Outlines of a Course of Lectures on the Practice of Medicine*, as delivered in the Medical School of Guy's Hospital by William Babbington and James Curry, 1802, p. 194.

this teaching more widely known; probably he was the first to show the association with pericarditis, although some think that priority should be given to Addison. Bright pointed out that erythema is another associated condition, and he mentions sore throat.

DISEASES OF THE ABDOMEN

Bright published a series of papers in the *Guy's Hospital Reports* on Abdominal Tumours. These received the honour of being reprinted as a separate book.*

The first chapter shows how to examine the abdomen; the second contains a description of fifteen cases of abdominal hydatid disease. Here again we see his originality, for Barlow says: "It is but due to the memory of Bright to state, though without any desire of imputing plagiarism to more recent continental pathologists, that the description of acephalocyst hydatids, is altogether original, and certainly an anticipation of similar observations which have since been published in Germany." Chapter III contains twenty-nine cases of ovarian tumour and is worth reading, for, now that ovarian tumours are removed, many practitioners do not appreciate the huge size they may attain. Then there follow twenty-eight cases of tumour of the spleen, twelve of the kidney, and thirty-three bearing on the subject of tumours of the liver. All these hundred and seventeen cases are most carefully reported; each is a clinical lecture in itself. What proportion of this mass of clinical observations is original it is impossible to say, for we cannot be sure of the exact state of knowledge at the time, but the whole series should be read as we read classical clinical lectures, namely, to enjoy and to learn from the description of a master, who is an observer and can appreciate the value and relation of the facts he records.

Bright's most original paper among his many on abdominal diseases was "Cases and Observations connected with Disease of the Pancreas and Duodenum."† These cases he says, "are chiefly intended to call the attention of the Members to a particular symptom in disease which I believe to have been but little noticed. . . . The symptom to which I refer is a peculiar condition of the alvine evacuation, a portion more or less considerable assuming the character of an oily substance resembling fat, which either passes separately from the bowels

* *Clinical Memoirs on Abdominal Tumours and Intumescence*, by the late Dr. Bright. Edited by G. Hilario Barlow, M.D., M.A., Physician to Guy's Hospital. The New Sydenham Society, London, 1860.

† *Medico-Chirurgical Transactions*, xviii. 1832-33.

or soon divides itself from the general mass, and lies upon the surface, sometimes forming a thick crust particularly about the edges of the vessel, if the fæces are of a semi-fluid consistence, sometimes floating like globules of tallow which have been melted and become cold, and sometimes assuming the form of a thin fatty pellicle over the whole or over the fluid parts, in which the more solid figured fæces are deposited. This oily matter has generally a slight yellow tinge and a most disgustingly fetid odour."

The first case was that of a man aged forty-five, who had considerable glycosuria; this Bright abolished by diminishing the carbohydrates in the food. The patient was jaundiced; a tumour was felt in the upper right part of the abdomen, and on several occasions during the last few weeks of his life he passed "a quantity of yellowish fatty matter much resembling butter that had been melted and had again become solid. This matter followed the fæces and, as it was evacuated in a melting state, it was perceived on the surface of the dejection." The *sectio cadaveris* revealed malignant disease of the head of the pancreas, firmly adherent to the duodenum on the inner surface of which it formed an ulceration. Bright had during the patient's life shown that the fatty stools could not proceed from fat taken by the mouth, for, when this was stopped, the stools remained fatty. The second patient, a woman, aged fifty, passed similar motions; she was jaundiced. Bright was much interested and predicted that the condition would resemble that of the first case. As her husband would not let her remain in the hospital, Bright persuaded him to let him know when she died, so that he might make a post-mortem examination. The husband did; Bright at once went to Gravesend and found malignant disease of the pancreas ulcerating into the duodenum. The third patient, a woman aged twenty-one, passed similar motions and was jaundiced; in her case also a tumour of the pancreas and duodenal ulceration were found. The rest of the paper consists of a masterly discussion of these cases and a consideration of the possible causes for these stools. Bright reaches the conclusion that their occurrence is symptomatic of pancreatic disease, but, as in all these cases the malignant disease of the pancreas had ulcerated into the duodenum, it is impossible to say for certain whether or not it is necessary for the pancreatic disease to ulcerate into the duodenum for the symptom to be present.

This paper apparently aroused interest, for at the next meeting of the Society, a fortnight later, two papers on the subject of fatty stools were read. The first by E. A. Lloyd

supported Bright, for it was an account of a man who had passed stools exactly like those described; at the autopsy disease of the pancreas was found. The second paper by Elliotson was merely historical; it quoted instances of fatty stools from old authors, but there was no reference to the relation of these to disease of the pancreas.

It will be noticed that the first of Bright's patients had glycosuria. He was well aware that this might occur with disease of the pancreas, for in *Reports of Medical Cases* (Vol. II., p. 262) we find him saying "Sometimes the pancreas has given evidence of congestion, and in one case in which icterus was combined with diabetes the pancreas was the seat of extreme scirrhus degeneration."

In a paper * entitled "Observations on Jaundice" he mentions that fatty stools are present when the pancreatic duct is implicated in disease. There is an admirable description of jaundice and its causes. Cirrhosis of the liver due to alcohol is given as one cause of jaundice, and Bright knew that the liver in this disease may be at first large and then contract, for he says (p. 612) "the liver is sometimes increased in its size; but very frequently quite the contrary, the organ having evidently undergone contraction in the progress of the disease: indeed, I have in some cases most distinctly traced its enlargement in the beginning of the attack and its gradual diminution towards the more confirmed stages of disorganization."

In this paper we have the first description of acute yellow atrophy of the liver; although Bright did not name the disease, he described it and its post-mortem appearances, for (on p. 614), he speaks of a febrile form of jaundice with cerebral symptoms and an excessive tendency to hæmorrhage. Two cases are described. Case 5 is headed *Jaundice of a most intense Character, without Mechanical Obstructions; and apparently depending on Inflammatory Action in the Liver*. "The liver only weighed two pounds, five ounces. It was soft and flaccid to the touch. . . . Its external appearance was mottled dark red liver colour with stone yellow colour." Case 6 is headed *Intense Jaundice without Mechanical Obstruction and apparently depending upon Inflammatory Action in the Substance of the Liver*. A girl aged eighteen suffered from jaundice and torpor; later she was delirious, had a rapid pulse and soon died. The liver was unusually small, "of a brightish yellow colour with portions marked with purple or deep brown." It is quite

* *Guy's Hospital Reports*, Vol. I., 1836, p. 604.

possible that Case 4 was also an example of this disease, for her liver was small, she was jaundiced and died from hæmorrhage. The last two cases in this paper are examples of pyæmic abscesses in the liver secondary to portal phlebitis, but it is clear that Bright did not recognise the relationship between the two conditions; he was inclined to regard multiple abscesses in the liver as a later stage of acute yellow atrophy and the condition of the portal vein as secondary to that of the liver.

In the same volume * is an extraordinary case of diaphragmatic hernia, which has escaped the notice of nearly all who are interested in the subject. It is recorded as "Account of a remarkable misplacement of the Stomach." The patient, a girl, died at the age of nineteen. From birth she had been delicate, suffering chiefly from sickness and dyspnœa; her mother had frequently noticed a gurgling noise in her chest. On October 14, 1835, she was admitted into Guy's under Bright for severe vomiting; he found the heart on the right side with no respiratory murmur in the lower part of the chest. She finally died from excessive vomiting. At the examination after death, the left side of the chest was fallen in, the heart in its pericardium lay mostly to the right. In the left chest was a red tumour rising to the fourth rib with a small portion of lung overlapping it; in the right chest was a similar tumour and the lung descended to the seventh rib. These two tumours were really one, formed by the stomach contained in a membranous bag over parts of which a scanty distribution of muscular fibres could be traced. On opening this bag, the stomach and omentum were seen; the œsophagus, at the fourth dorsal vertebra, entered the stomach which, filling all the lower part of the left chest, passed behind the heart where it was contracted, and expanding again filled the lower part of the right chest; it then passed through the diaphragm near the vena cava, the duodenum running in a straight line downwards to the head of the pancreas. The cyst which enveloped the stomach, without adhering to it, appeared to be formed by a congenital splitting of the diaphragm. On the left side there seemed to be a third division of this structure going to envelop the spleen, which was in a sac like the pericardium. The stomach was very large; its contents nearly filled a wash-hand basin and there were two or three chronic ulcers in it. The duodenum was dilated.

Chronic peritonitis interested Bright, for he published a paper † entitled "Cases and Observations illustrative of

* *Guy's Hospital Reports*, Vol. I., 1836, p. 598.

† *Medico-Chirurgical Transactions*, Vol. XIX., 1833-35, p. 176.

diagnosis when adhesions have taken place in the Peritoneum with remarks on some other morbid changes of that membrane." He says: "I have observed on several occasions, that when the circumstances of the disease had rendered it probable that adhesions might take place between the viscera and the peritoneum of the abdomen, a very peculiar sensation has been communicated to the touch, varying between crepitation produced by emphysema and the sensation derived from bending new leather in the hand. And in each of the cases which I shall now detail I have had the opportunity of discovering, by examination after death, that such adhesions had existed in the parts where this sensation was discoverable; whereas in no case have I observed the phenomenon and ascertained that the particular morbid condition did not exist." This point in diagnosis has "as far as I know hitherto escaped observation." Several cases of chronic peritonitis in which this sign was present are recorded.

Then follows what is probably the first description of the peritonitis, which is called nowadays chronic proliferative peritonitis or simple chronic peritonitis. The account of it runs thus: "One of the most frequent morbid changes in the peritoneum is when the whole is covered with an evenly distributed false membrane, which renders it, in its general appearance, opaque, and is apt to contract the loose folds of the membrane and those by which the various viscera are suspended or attached, and likewise to form a kind of compressing ligature about all the viscera themselves; the result of which is, that the omentum gradually becomes shortened and corrugated, ultimately forming but a narrow band along the arch of the stomach and the colon—the mesentery becomes shortened, and the intestines, by this means drawn towards the spine—the calibre of the intestines themselves becomes diminished and they are most obviously shortened in their course—the liver is drawn close to the diaphragm and the spleen to the stomach—while the kidneys are fixed more firmly into the cavities formed by the muscles of the loins,—and all these viscera are compressed in a degree which often produces alteration in their shape. . . . This false membrane is polished, like the peritoneum, and at first sight gives the idea of a thickening and opacity of the membrane itself; but upon examination it is found capable of being removed and stripped off in large flakes, leaving the surface of the peritoneum polished and entire. This I should consider the product of a very low stage of chronic inflammation." The author then points out that the condition can be diagnosed if there is fluid in the abdomen, for then,

owing to the intestines being retracted, there will be a dull note in front. He remarks upon the honeycomb appearance of the membrane over the liver and spleen.

To Bright must be given the credit of being the first to describe Addison's disease, but in no sense did he discover the disease, for he did not connect the symptoms with disease of the suprarenals. The merit of this is entirely due to Addison. Bright's case * was that of a woman admitted into Guy's in July 1829. She was greatly emaciated and apparently sinking. "Her complexion was very dark." She had vomiting, became drowsy and died. At the *sectio cadaveris* slight evidence of chronic phthisis was found, but "the only marked disease was in the renal capsules, both of which were enlarged, lobulated, and the seat of morbid deposits apparently of a scrofulous character; they were at least four times their natural thickness, feeling solid and hard; on the left side one part had gone into suppuration, containing two drams of yellow pus." This specimen is still in the Guy's Museum and is probably the earliest specimen illustrating Addison's disease. Its number in the catalogue is 1544.

In London, in 1889, was published Volume I. of *Elements of the Practice of Medicine*, by Richard Bright, M.D., and Thomas Addison, M.D. Volume II. never appeared and the first volume is a rarity; therefore it is not generally known that it contains the first accurate account of what we call appendicitis. No reference to this occurs in the first six text-books which I took up by chance, and Deaver,† in his very full history of the disease, does not mention it, but Kelly‡ does, in these words: "descriptions so clear and well presented that they could not be surpassed to-day."

Bright and Addison wrote, on page 498 of their book, under the heading, *Inflammation of the Cæcum and Vermiform Appendix*: "The history of this affection is often as follows: The patient has complained, more or less, for some time past, of pain and uneasiness in this part, increased on exertion, or after neglect of the bowels, or excess in eating or drinking; he has, however, retained such a share of health, that he has not been interrupted in his daily avocations, till, after some unusual exposure to cold, some long walk, or other over-exertion, he has been suddenly seized with a more severe pain, attended with rigors, chills and sometimes with sickness and violent vomiting. The pain and tenderness become excessive, and extend to the

* *Medical Reports*, Vol. II. p. 247, Case 119.

† Deaver. *A Treatise on Appendicitis*, 1900.

‡ Kelly. *Appendicitis*, 1909.

neighbouring parts of the abdomen. A hardness and tumefaction are soon very evident to the hand in the part first affected. This continuing, general symptoms of peritonitis often take place, and terminate fatally, but under careful treatment, the inflammation remains circumscribed, and becomes less extensive, assuming the form of a local, deep-seated abscess. The threatening symptoms of peritonitis subside; the tumefaction just above the crest of the ilium on the right side is more and more obvious to the touch, and gradually shows a tendency to point, the constitution still suffering severely. In process of time it either opens of its own accord, or is assisted by the lancet, and a discharge of ill-conditioned pus follows, which from its peculiar fetid smell, and from its appearance, is soon discovered to be mingled with feculent matter. The discharge continues for many weeks, and the patient often sinks at length from exhaustion. In other cases, when the powers of the system are previously unbroken, the abscess closes and permanent recovery is obtained."

Morbid Appearances.—"From numerous dissections it is proved that the fæcal abscess thus formed in the right iliac region arises, in the large majority of cases, from disease set up in the appendix cæci. It is found that this organ is very subject to inflammation, to ulceration and even to gangrene . . . so that this little worm-like body is often detected in the midst of the abscess, with a perforation at its extremity, or with ulceration higher up in its parietes, a considerable portion of it, nearly or entirely separated, is found in a disorganised condition among the pus and fæces which fill the abscess." The authors go on to indicate that an appendix abscess may point at a considerable distance from the original source of the disease.

DISEASES OF THE THORAX

We have seen * that the first part of Bright's *Reports of Medical Cases* is occupied with an account of the disease bearing his name. The remainder of Volume I. is concerned with diseases of other organs than the kidneys. Although there is nothing in it that arrests us as being a new discovery, yet we cannot but admire the completeness and accuracy of the descriptions of the clinical and post-mortem appearances. They are much better than most of those which have followed. The author gives examples of dropsy due to disease—notably that of the heart—within the chest. Fatal acute bronchitis is described. We get a picture of the horrible winter 1818-14,

* *Guy's Hospital Reports*, lxxi. I. 1921.

when "the almost unexampled continuance of dense fog and the severe frost which followed, appeared to influence in a peculiar manner the lining membrane of the bronchi." The disease "returns generally each successive winter with increased violence, by far the greater number of severe cases occur in those who have long passed the meridian of life." Pulmonary abscess following pneumonia is recorded, and so are some examples of gangrene of the lung. There is an excellent description of phthisis. There are two varieties, one in which the change consists chiefly in the formation of fibrous tissue and cavities, the other in which miliary tubercles predominate. The alterations in the intestines may be merely signs of inflammation or of ulceration, and Bright considers that one cause of wasting is that the proper absorption of food is prevented by the disease of the mesenteric glands. He insists upon the necessity of trying to check the diarrhoea which may accompany phthisis.

He became interested in what we now know to be post-mortem staining of the arteries. Was it due to the blood or to the vessels supplying the wall of the aorta? A patient died in Guy's and Bright wished to see the aorta, but a post-mortem examination was refused and the body was taken away. Bright, however, ultimately obtained permission and went to the patient's house the third day after death to make the examination. The first volume concludes with an account of the morbid appearances in typhoid fever.

It must be news to many to hear that Bright gave oxygen to those suffering from respiratory distress,* but the case of a boy aged fourteen is described. "At eleven o'clock he inhaled a bladder of oxygen gas; this was followed for a short time by longer and deeper respirations, and there was a transient amendment in the expression of the countenance and a slight temporary redness in the face." . . . "Oxygen gas frequently inhaled," . . . "never failed to produce a temporary excitement during which the eyes opened and the respiratory muscles were called into increased action."

Case 129 in the same volume (p. 270) is clearly one of heart block. The patient, a man aged forty-five, had frequent fits of an epileptic character in which he lost consciousness; his pulse "seldom rose above thirty beats in the minute and sometimes it did not exceed twenty-two. . . . He frequently complained of difficulty of breathing from a particular tightness at the chest; had a most uneasy feeling when he stooped his head, and he frequently felt faint when he sat erect or dozed." He

* *Reports of Medical Cases*, Vol. II. p. 226.

died suddenly. The heart was at least twice the natural size, and no organic lesion was found to account satisfactorily for the sudden dissolution.

Bright also described the condition of the lung in whooping cough. In Case 98, "small portions of the lungs were hepatised at the edges of the lobes, there was a muco-purulent fluid in the air cells and ramifications of the bronchi." In Case 99, "many of the lobules about the edges of the lungs were flattened as if they had not admitted of the ingress of air for a considerable time. The bronchial tubes were a good deal loaded with viscid mucus." This is probably the first description of the broncho-pneumonia and pulmonary collapse seen in whooping cough.

STUDIES IN GASTRIC SECRETION

IV. SOME INDIVIDUAL EXPERIMENTS WITH THE GASTRIC TUBE

By J. A. RYLE, M.D., Assistant Physician to Guy's Hospital.

THE experiments detailed hereunder were performed by the writer on himself. Undertaken in the first instance with a view to ascertaining (1) the degree of discomfort associated with swallowing and retaining the tube, and (2) the secretory response to a standard test-meal in a healthy subject, they were continued in the hope of collecting further physiological data in regard to gastric function.

The investigations included—

(a) A study of the motor and secretory response to various foodstuffs. Test-meals consisting of oatmeal-gruel, milk, skimmed milk, a suspension of cream, water, and a solution of sugar were employed among others.

(b) A study of the resting-secretion withdrawn on rising in the morning over a period of thirty-one days, and the influence of variations in the salt-intake on the output of resting-secretion.

(c) A record of gastric peristaltic sensations noted during the course of certain test-meals.

(d) Other occasional observations.

On no occasion was any real difficulty experienced in swallowing the tube, and after the first trial no unpleasant symptoms of any kind were noted. Nausea and salivation were absent. Talking and even mastication were not interfered with.

SECTION A

(1) *Response to the standard test-meal (one pint of oatmeal gruel).*—Chart I illustrates the response to the standard test-meal and corresponds with the type of chart obtained in about 80 per cent. of healthy males. The test was performed on four occasions and in each instance gave closely similar readings. On the last occasion only, when the test was performed in bed

and after a week of slight indisposition accompanied by hiccough and vague epigastric discomfort, emptying was delayed one

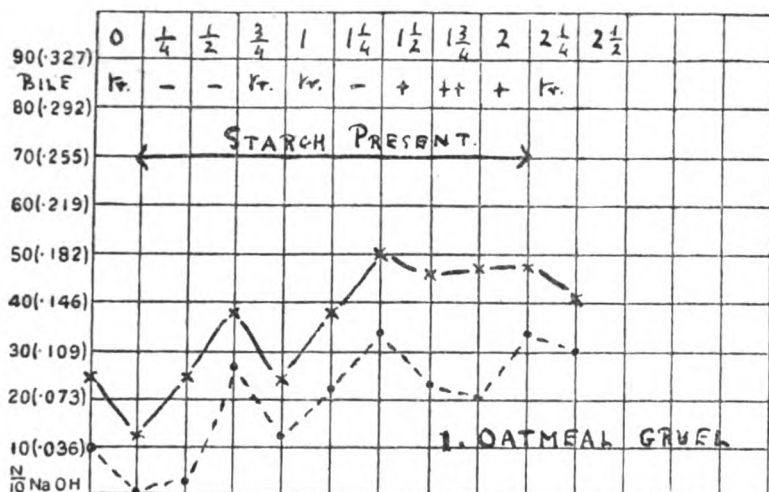


CHART I.

Illustrating response to Boas' oatmeal gruel test-meal, one pint. Dotted line represents free HCl. Continuous line represents total acidity.

quarter of an hour, but the curve of acidity showed no divergence from the type obtained on the three previous occasions. The descent in the curve of free acidity at one hour and again at

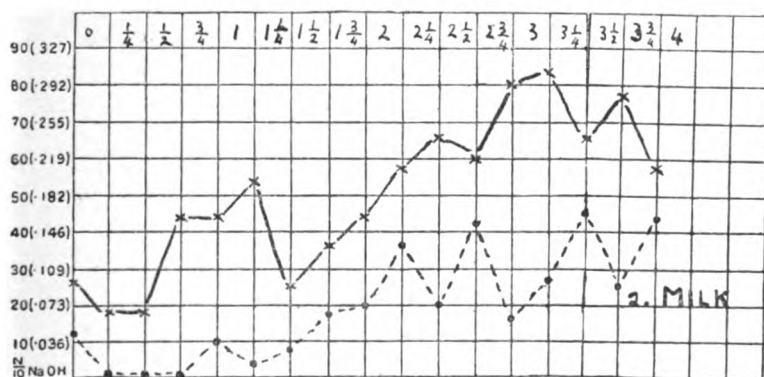


CHART II.

Illustrating response to milk test-meal, one pint.

two hours coincides with the occurrence of duodenal reflux as indicated by the appearance of bile. Starch disappears in the penultimate specimen. Free and total acidity run closely parallel.

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The dotted line represents the free acid, the continuous line the total acidity in all the charts.

(2) *Response to milk test-meal (one pint).*—The rate of empty-

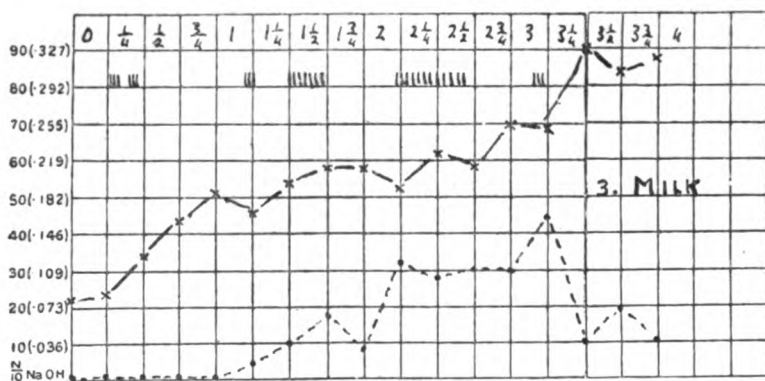


CHART III.

Repetition of milk test-meal, with records of "peristaltic sensations."

ing is much slower, the test lasting four hours. There is a slow, gradual climb in the acidity, the free acidity reaching a point higher than at any period in any of the gruel test-meals,

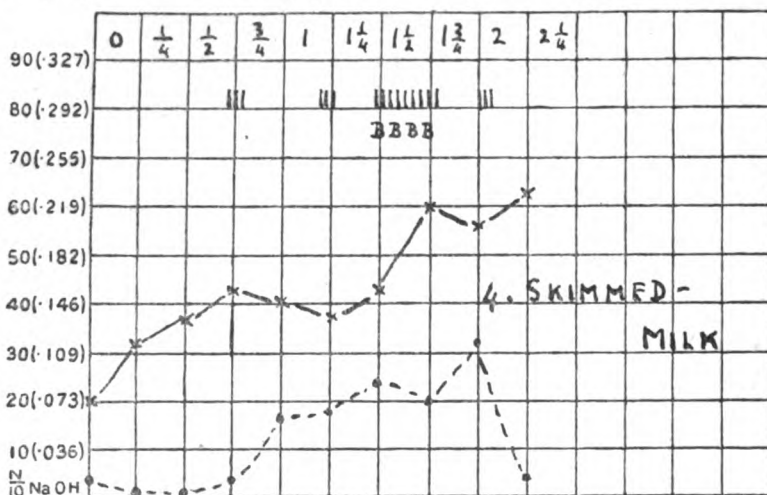


CHART IV.

Illustrating response to skimmed milk test-meal, one pint, with records of "peristaltic sensations."

and the total acidity exceeding eighty at three and a quarter hours. There is an inverse relationship between free and total acidity, the high peaks in the total acidity corresponding with a drop in the curve of free acidity.

The explanation of this would appear to depend upon the combination of acid with the milk-protein. The greater the amount of combined acid at a given moment the lower will the reading of free acidity tend to be.

The high acid figures would seem to suggest either a specific response to the milk-protein or more probably the effect of delayed emptying. The same phenomena and the same rate of emptying were recorded in a repetition of the test (see chart III).

(3) *Response to skimmed milk test-meal (one pint).*—The rate of emptying is two and a quarter hours, suggesting that the delayed emptying with the whole milk is attributable to



CHART V.

Illustrating response to suspension of cream. One and a quarter ounces in one pint of water, with records of "peristaltic sensations."

the fat content. The same inverse ratio of free and total acidity will be observed (chart IV).

(4) *Response of cream test-meal (one and a quarter ounces suspended in water to one pint).*—After the initial rise in acidity, which is probably due to the water, there is a very low curve of free acid and a much delayed emptying, the inhibitory action of fats both on motor and secretory activity being well demonstrated. The explanation of the flat, sustained curve of total acidity is not quite apparent, unless it represents combined acid-protein provided by some small admixture of milk-protein with the cream (chart V).

(5) *Response to water (half a pint).*—There is a definite secretory response to water in the writer's case, though the response appears to be variable and often absent in other individuals. Emptying takes fifty-five minutes; at sixty

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minutes there was copious bile regurgitation and 40 c.c. of bile-stained fluid were withdrawn (chart VI).

(6) *Response to solution of sugar (one ounce in half a pint of water).*—There is a delayed rise in the acidity and a curve of low elevation as compared with the water-test (chart VII).

(7) *Response to orange-juice (half a pint made up to one pint with water).*—This experiment was undertaken with a view to ascertaining if there might exist any obvious contra-indication to the administration of fruit-juice to patients on a strict ulcer

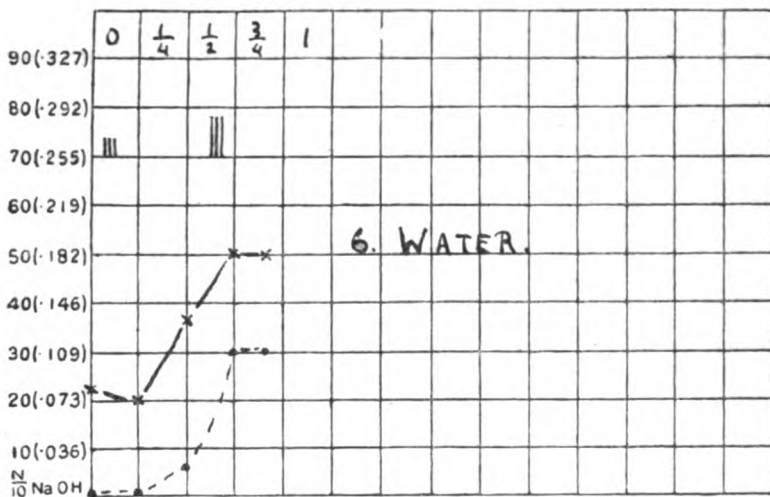


CHART VI.

Illustrating response to water, half a pint, with records of "peristaltic sensations." The long strokes indicate more than usually vigorous "peristaltic sensations," which were quickly followed by complete emptying.

diet, a diet sometimes low in its antiscorbutic element and always rather dull. Excepting at three and a half hours, where strong hunger-sensations were being felt, the free acid is no higher than in the gruel-test. The rate of emptying is slow. The high initial total acidity is presumably due to the organic acids in the fruit-juice (chart VIII).

(8) *Response to tea and milk (half a pint) with sugar.*—The acidity reaches a slightly higher figure than in any of the gruel-tests. The test was discontinued at one and a half hours when 50 c.c. of mixed gastric and duodenal secretion were withdrawn (chart IX).

SECTION B

The resting-secretion and the influence of the salt-intake.—During a period of thirty-one days the resting-juice was with-

drawn on rising each morning. The resting-juice varied from "1 or 2 c.c. obtained with difficulty" to "15 or 30 c.c. obtained with ease." Unfortunately the amounts were not accurately recorded as the importance of such measurements was not at the time recognised.

The free acidity varied between 0 and 22, the total acidity between 4 and 38. Mucus was present in small amount. The presence of bile was variable. Not infrequently bile was absent in the first half and present in the second half of a specimen, suggesting that aspiration from the duodenum through a patent

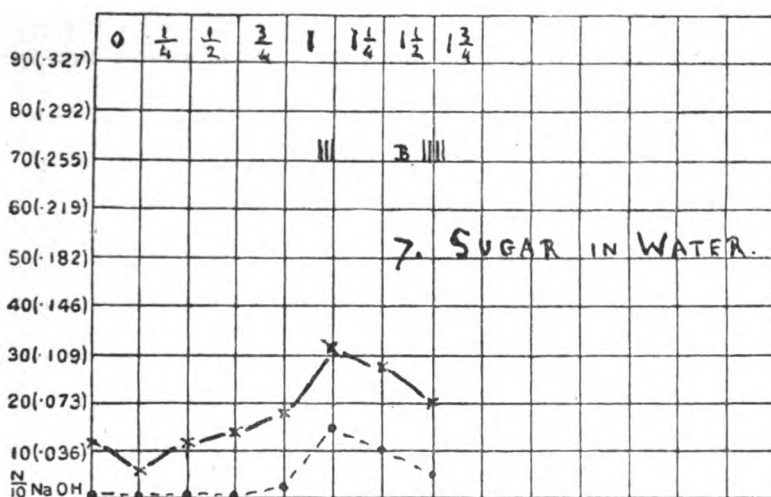


CHART VII.

Illustrating response to sugar, one ounce, in water, half a pint, with record of "peristaltic sensations."

pylorus had occurred. The whole of this investigation is described in more detail in a paper in course of preparation by T. I. Bennett and the writer.

The conclusions in regard to the effect of salt-deprivation were briefly to the effect that there was no demonstrable modification induced in the secretory response to a standard meal, but that there seemed to be a decreased quantity of resting-secretion throughout the actual period of salt-deficiency.

SECTION C

Although customarily quite unaware of any subjective sensations during the period of gastric digestion, the writer had not long been employed in the investigation of his own gastric responses before he became familiar with certain definite

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gastric sensations, hereafter referred to as "peristaltic sensations." These sensations were momentary and appeared to arise in waves or groups, and can only be described as being akin to something between hunger and mild nausea. The large bulk of fluid or semi-fluid meal may have been responsible for their origination, but the fact that they were at times associated with audible borborygmi and that they were subsequently found to coincide with certain phases of gastric secretion, while mental distraction by reading or conversation did not influence the writer's appreciation of their presence, would seem to establish them as genuine gastric sensations. Carlson¹ has shown that hunger-sensations are dependent on variations in gastric tonus. Under normal conditions of satisfaction with

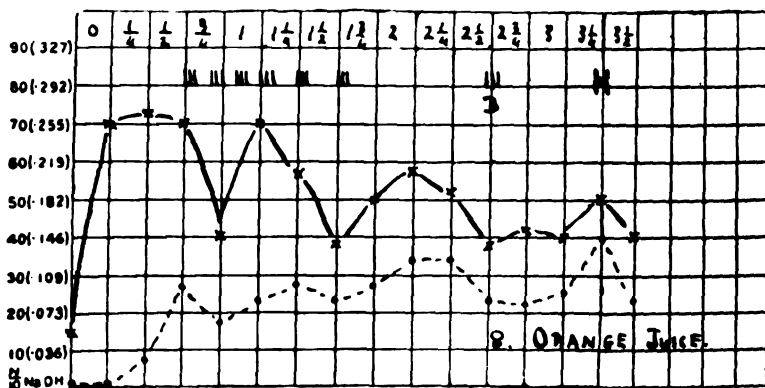


CHART VIII.

Illustrating response to orange-juice, with record of "peristaltic sensations."

food we are unaware of the changes in tonus which accompany peristaltic activity, but with a tube in place and communicating with the outer air it will be apparent that the intra-gastric pressure changes during peristalsis will be modified, perhaps sufficiently to become appreciable.

On this hypothesis the writer would endeavour to explain the fact that he is aware of certain gastric sensations with the tube in place, but not under normal conditions.

Occasionally very slight pain in the pyloric region was experienced, and once or twice unmistakable hunger towards the end of a test.

Peristaltic sensations are recorded as upright strokes in the charts; hunger as H; and borborygmi as B.

Reference to various charts will show that these peristaltic sensations reach their maximum frequency during the period

of maximum secretory activity, and are scarce or absent, as a rule, when secretion is scanty. These findings would appear to indicate that the vagus influences proportionally and simultaneously the motor and secretory activities of the stomach.

In the skimmed milk test-meal the maximum acidity coincides with the period of maximum peristaltic activity as indicated not only by peristaltic sensations, but also by the recognition of audible borborygmi. These borborygmi commonly appear to originate in the right upper quadrant of the abdomen. In the fruit-juice meal the terminal spike of acidity coincides with a moment of definite hunger.

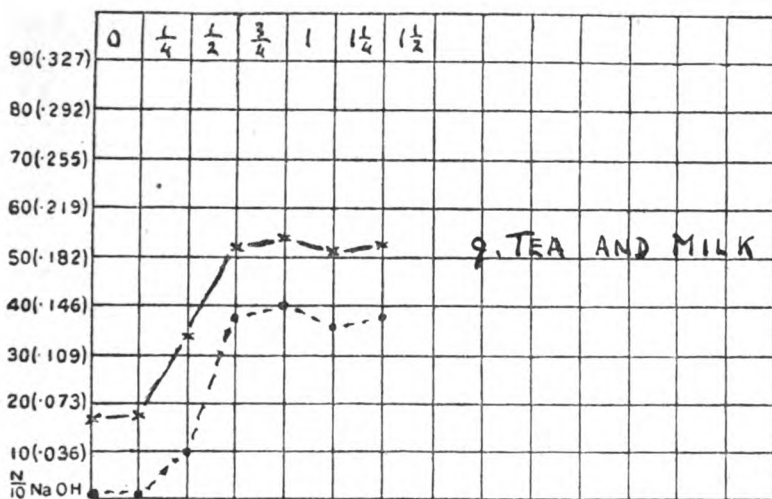


CHART IX.

Illustrating response to tea and milk, half a pint.

SECTION D

Among the occasional experiments may be included—

- (1) An inquiry into the rate of passage into the duodenum of the bulb of the gastric tube;
- (2) The location of duodenal sensation;
- (3) The effect of asafetida in the mouth on gastric secretion.

(1) It was found that by swallowing the tube to the pylorus mark and lying on the right side the bulb passed into the duodenum in from five to ten minutes. The arrival of the bulb in the duodenum is determined (a) by x-ray screening, (b) by the withdrawal of duodenal juice. Under the rays it is possible to observe the bulb making attempts to pass the pylorus, then taking an upward course towards the duodenal cap, until,

having passed the cap, it lies pointing obliquely downwards and to the right.

Dr. T. I. Bennett and Mr. F. Cook also passed the tube into the duodenum on the same occasion, and the writer is indebted to them for permission to quote the experiment described hereunder, which was made at the suggestion of Dr. A. F. Hurst.

(2) Observations as to the position of duodenal sensation were made by blowing air down the tube. In each case there was produced a definite sensation felt under a point on the surface as follows—

T.I.B.	2½"	above umbilicus	1½"	to right of mid-line.
F.C.	2½"	"	1½"	" " "
J.A.R.	3"	"	2¾"	" " "

(3) In an attempt to study the effects of a nauseous substance the writer held a solution of asafetida in the mouth, with the tube in position and the stomach in a fasting condition. The resting-juice was allowed to syphon and was dripping at a slow rate before the introduction of the asafetida, which was not swallowed. Twenty or thirty seconds after the introduction of the asafetida, when a strong tingling sensation was experienced locally by the tongue, but no nausea, secretion poured rapidly from the tube. The mouth was then washed out and the experiment repeated with the same result. The analysis of the three samples gave the following results—

<i>Specimen</i>	<i>Bile</i>	<i>Free</i>	<i>Total</i>
Resting	a trace	18	36
1st	++	26	44
2nd	++	45	62

Thus the last specimen, although mixed with duodenal secretion, showed a higher acidity than that shown at the height of the secretory curve in the gruel-meal and twice as high as the highest recorded resting acidity. There was apparently a vigorous reflex secretion by the gastric glands as the result of buccal irritation.

DISCUSSION

It will be obvious that the majority of the foregoing experiments need repetition and confirmation, but no apology is made for recounting them here, as it is felt that, by indicating the simplicity of the methods employed and the comparative rapidity with which results may be obtained, they might serve to point the way for further investigations along similar lines.

Throughout the experiments the writer was watchful for indications which might prove helpful in practical medicine and particularly in the treatment of gastric disorders. The results obtained in the case of milk would seem to call for an inquiry into the relative value of milk and other foodstuffs in the treatment of ulcer. If milk produces a higher and more prolonged secretion of acid than, for instance, an equivalent bulk of gruel is it as desirable a food for ulcer patients? Though it may be claimed that the milk-protein neutralises free acid, it does not do so entirely or all the time, and the opportunity for ulcer-protein to combine with the acid is equally good during a long period of the meal. Further if the maximum physiological rest obtainable is desirable for the healing of an ulcer, is a diet which produces a high degree of motor as well as secretory activity, as judged by the acid curve and the frequency of peristaltic sensations, the best one to employ?

The experiments would seem to indicate that cream, gruels and sugar may perhaps be more desirable foodstuffs than milk. Fruit-juices would not appear to be especially contra-indicated. Tea produced a higher curve than any other substances excepting the milk. Salt which possibly influences the interprandial secretion and condiments causing buccal irritation, which have long been disallowed on theoretical grounds, would both seem undesirable practically.

Finally the records of sensation and the experiment with intra-duodenal insufflation help to support previous work on gastro-intestinal sensibility, and to confirm its dependence on tonus variations.

REFERENCE

- ¹ A. J. Carlson: *The Control of Hunger in Health and Disease*. Chicago, 1916.

NOTE.—The publication of the *Report by T. I. Bennett and J. A. Ryle on the Investigation of a Hundred Normal Individuals by the Fractional Method*, has been unavoidably postponed until the next issue.

HOUR-GLASS CONTRACTION OF THE STOMACH

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital, and
R. P. ROWLANDS, M.S., Surgeon to Guy's Hospital.

"A woman of forty years of age, of a yellowish complexion, had long been troubled of a hardness in her belly. . . . If you touched the tumid part it was painful. She was thirsty. For about a month before her death, she complained of a pain in her stomach, after taking food. . . . On some of her latter days a vomiting had come on; but on the two last, a very severe and violent pain.

"The abdomen was found full of a yellow water. . . . The stomach was narrow in the middle, so as to resemble the streightness of the pylorus, and, in some measure, to bear the appearance of two stomachs."—Morgagni: *De Sedibus et Causis Morborum*, Letter XXXVI, Alexander's translation, London, 1769.

ETIOLOGY AND PATHOLOGY

ALTHOUGH at one time hour-glass contraction of the stomach was thought to be congenital, it is now known that this is hardly ever the case. Brook¹ operated on a woman with an hour-glass stomach in 1904, and was unable to find any trace of ulceration, thickening or scarring, on inspection of the stomach both from within and without. This is the only satisfactory record of a case we have found, in which the deformity appears to have been congenital in origin, with the exception of one in which a congenital gastric fistula led to contraction at the site of the fistula.

Hour-glass contraction of the stomach is almost invariably secondary to a chronic ulcer, which is usually situated on the lesser curvature. The condition was present in 6 per cent. of the cases of chronic gastric ulcer coming to operation at the Mayo Clinic. The ulcer is deep, involving all the coats of the stomach, and is generally intimately adherent to the liver or pancreas or less frequently to the anterior abdominal wall. As the walls of the stomach gradually become indurated, the greater curvature becomes drawn up by perigastric adhesions, and a definite organic stricture results. The ulceration almost always persists along the upper border of the stricture, and the accompanying congestion and œdema round the ulcer and spasm of the circular muscle fibres of the affected segment of the stomach increase the obstruction. The upper pouch is generally the smaller because of the high position of the ulcer. The stomach is occasionally trilocular, owing to the

contraction of two ulcers. In rare cases carcinoma of the stomach produces an hour-glass contraction, or an ulcer of the lesser curvature becomes malignant, the hour-glass contraction thereby becoming exaggerated. But less than 1 per cent. of cases of hour-glass stomach are caused by growth. Eusterman² has recorded three cases of syphilitic hour-glass stomach, and there is a specimen in the Guy's Museum, in which the hour-glass contraction followed gastrectomy.

One of us (R.P.R.) has operated on three cases of hour-glass stomach caused by bands round the stomach slinging up the greater curvature. In one of these a broad sling had resulted from perforation of a gastric ulcer; in another, the obstruction was due to a sling of adhesions around the stomach, arising in a cretaceous gland a little below the œsophagus; and, in the third no explanation could be found for the presence of a thin, strong band, running across the stomach from the lesser omentum above the middle of the lesser curvature to the great omentum just below the stomach, which obviously constricted it by holding up the greater curvature.

Pyloric stenosis is present in about 25 per cent. of cases of hour-glass contraction. It appears probable—especially when the pyloric ulcer has healed—that the pyloric stenosis is primary, and that the secondary gastric stasis and continuous hypersecretion lead to the development of a second ulcer in the stomach.

At least 80 per cent. of the patients are women, in spite of the greater frequency of gastric and duodenal ulcers in men. Out of seventy-eight cases examined by Thurston Holland³ with the x-rays, in which the diagnosis was confirmed by operation, no fewer than seventy-three were in women; thirty-one out of forty-one of Mathieu's⁴ cases and seventeen out of nineteen of Reizenstein and Fier's⁵ cases were in women. The three series of cases taken together give a percentage of eighty-five women and fifteen men.

SYMPTOMS

The symptoms of hour-glass stomach are those of a chronic gastric ulcer, which has been present for many years. At a certain period of the history symptoms of obstruction are gradually added to those of the uncomplicated ulcer.

It is rare for the history to be as short as a year, and in two of our cases it was as long as forty and forty-four years respectively. The chronic course of the disease is due to the position of the ulcer opposite a wide part of the stomach,

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where changes must be in progress for a long period before obstruction can occur. It is notable that in the only one of our cases in which the ulcer was in the pre-pyloric region, the symptoms progressed far more rapidly, and terminated in tetany within two years of the first symptoms.

The symptoms are in most cases at first intermittent periods of indigestion alternating with periods of complete freedom. Gradually the former lengthen and the latter become shorter and less frequent, until finally the symptoms recur every day after every meal without intermission.

The pain generally begins between one or two hours after meals, but in the later stages, when obstruction is developing, the onset is often earlier and may be immediately after taking food. In the later stages the pain may be more or less constant, although it is still aggravated by taking food, and relieved by vomiting and by alkalies. It is generally situated in the middle of the epigastrium or slightly to the left and very rarely to the right. It tends to radiate upwards into the chest and occasionally even to the left shoulder; it may also pass to the left side of the spine, and rarely to the left loin or left iliac fossa.

The upper part of the left rectus is more rigid than the right, and the muscle and subcutaneous tissues may be tender, especially when the pain is most severe. Apart from this referred tenderness, the ulcer itself is invariably tender if pressure is exerted directly upon it when it is visualised with the x-rays.

In some cases the ulcer forms a palpable tumour on the left side of the epigastrium, which is always tender.

In a third of the cases hæmatemesis occurs; in one of our cases this was twenty-six and in another thirty-three years before they came under our observation.

Vomiting, which is generally absent in the early years of the history, becomes increasingly frequent in the later stages. It has the character of the vomiting of pyloric obstruction, large quantities being brought up, which sometimes contain the residue of meals taken twelve or even twenty-four hours before.

Peristalsis can, in rare instances, be seen through the abdominal wall; much more frequently peristalsis in the upper segment can be seen with x-rays, although normally no peristalsis occurs in the proximal half of the stomach.

Nearly all the patients are very thin and feeble, so that malignant disease is often suspected. When the contraction is near the cardiac orifice and the upper pouch is very small,

such symptoms as dysphagia and inability to take any but very small feeds may suggest achalasia or cancer of the cardia.

Hyperchlorhydria and hypersecretion are usually present, but in a few late cases the acidity may be normal or sub-normal. Then carcinoma is likely to be suspected, but it should be remembered that complete achylia gastrica may occur with a simple ulcer of the lesser curvature, as Ryle has demonstrated by means of fractional test-meals.

DIAGNOSIS

The diagnosis of hour-glass stomach is rightly regarded as one of the greatest triumphs of radiography. Before the introduction of opaque meals, the condition was very rarely recognised before an exploratory operation or an autopsy revealed its presence. Though numerous signs of hour-glass stomach have from time to time been described, not one of them is pathognomonic, and all of them may be absent in quite well-marked cases. Thus in one patient, in whom the diagnosis had been definitely made with the aid of the x-rays, and in whom it was subsequently confirmed at operation, none of the seven signs collected together by Moynihan⁶ in his exhaustive paper on hour-glass stomach published in 1904 could be elicited on repeated examination.

Although in every case of organic hour-glass stomach the diagnosis can be made with far more ease and far more certainty with the x-rays than by any other method, a small number of cases have been reported and a large number remain unrecorded, in which the diagnosis made after an x-ray examination has not been confirmed at the subsequent operation. This is due to the fact that an hour-glass stomach may have a functional origin; it may be quite obvious when the patient is examined under natural conditions with the x-rays, although no evidence of its presence can be found either at operation or after death.

There are at least three different forms of functional hour-glass stomach. The existence of one of them was already suspected before the introduction of radiography, but our knowledge of its etiology and significance is due mainly to the x-ray investigations of Barclay⁷ in England and Jollasse⁸ and Jonas⁹ on the Continent. The other two forms of functional hour-glass stomach were first described by one of us¹⁰ (A. F. H.) in a paper published in 1910.

In addition to these conditions a partial hour-glass contraction may result from the pressure of a splenic flexure which is distended with gas. The distended colon can be easily

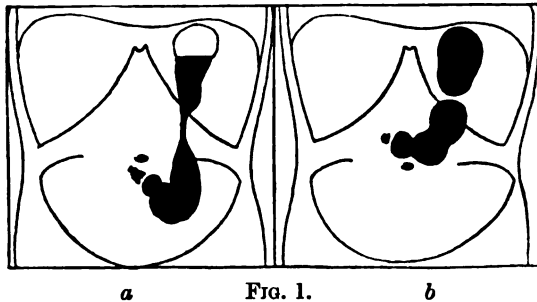
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recognised with the x-rays, and the deformity of the stomach at once disappears on lying down.

These three functional forms and the means by which they can be distinguished clinically from the organic hour-glass contraction of the stomach will now be described.

I.—SPASMODIC HOUR-GLASS STOMACH

Jollasse⁸ in 1906 expressed his belief that the typical x-ray appearance of an hour-glass stomach could result from spasm. The subsequent investigations of Barclay⁷ and Jonas⁹ conclusively proved that this is true, and it is now widely recognised that spasmodic hour-glass stomach is a comparatively common condition. It is most frequently due to the presence of an ulcer, which is generally situated on the lesser curvature and may be quite small. It appears to be as common in acute

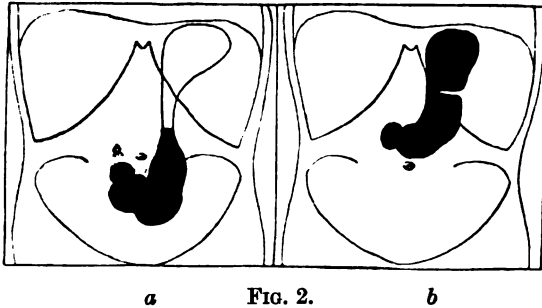


Spasmodic hour-glass stomach, due to a gastric ulcer: *a*, standing; *b*, lying.

ulcers involving only the mucous membrane, the existence of which cannot be recognised at a laparotomy by any external examination of the stomach, as in chronic ulcers, which produce obvious changes in the external appearance. A spasmodic hour-glass contraction may occur in chronic appendicitis, and less frequently with gall-stones and duodenal ulcer. In some cases, especially of appendicitis, this is probably due to the production of an acute ulcer of the stomach secondary to the other abdominal condition. Apart from this it must be caused by reflex activity. One of us (A. F. H.) has demonstrated that this is the case by pressing upon a tender appendix, which had become visible with the x-rays owing to the entry of some bismuth oxychloride into it; the stomach, rendered visible by a second opaque meal, was seen to develop a typical spasmodic contraction in its centre.

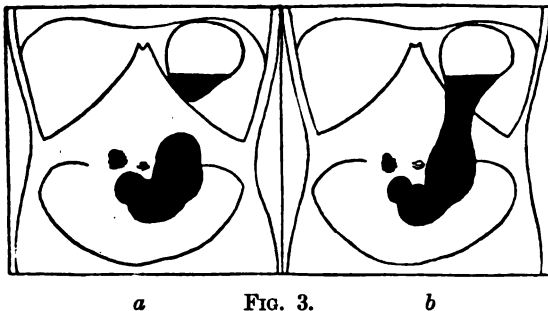
The neck of this form of functional hour-glass stomach passes from the lowest point of the upper segment, as it does

in the orthostatic form, which will be described directly, but it differs from the latter in that it persists on lying down (Fig. 1). In some cases, indeed, the spasm leads to a curious narrow depression on the greater curvature, seen in the horizontal position, although nothing more than a slight narrowing in the



Spasmodic hour-glass stomach, due to a gastric ulcer: *a*, standing; *b*, lying.

body of the stomach is visible on standing (Fig. 2). The spasm can sometimes be caused to disappear by abdominal massage and by vigorous voluntary contraction of the abdominal muscles (Fig. 8). At one time the injection of 1/100 gr. atropine was supposed to result always in relaxation of a spasmodic contraction (Rieder,¹¹ Jonas⁹), but Carman¹² has shown that



Spasmodic hour-glass stomach, standing: *a*, spasm present; *b*, spasm disappeared after vigorous contraction of abdominal muscles.

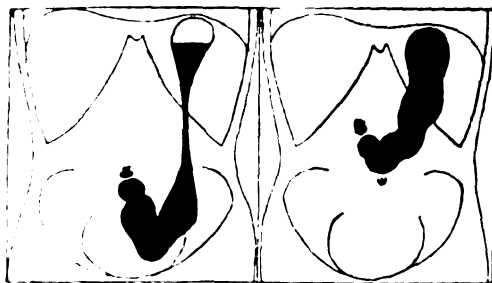
this only occurs when the spasm is secondary to some non-gastric disease and not when it is associated with a chronic gastric or duodenal ulcer. Moreover Reizenstein and Fier⁵ actually observed an exaggeration of the spasm in one case after injecting atropine. Carman recommends giving ℥xx of Tinct. Belladonnæ by mouth instead of injecting atropine, and then giving further doses of the drug until the mouth is dry and

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the eyes affected, as relaxation sometimes only occurs, even in extrinsic cases, with maximal doses.

The contracted area increases in length and the degree of spasm diminishes during a meal; when examinations are made at intervals of a few days it is found to vary in degree, and it may sometimes be completely absent. Spasmodic contraction does not prevent the rapid filling of the distal segment of the stomach, even whilst a meal is being taken, and never leads to peristalsis in the proximal segment; this is an important point in diagnosis, as peristalsis is often visible above the obstruction produced by an organic hour-glass contraction.

Partial organic hour-glass constriction, due to an ulcer which is still active, may be rendered complete by the occurrence of spasm, so that stenosis, thought to be severe from the



a FIG. 4. b

Gastropnoia: (a) standing; (b) lying.

x-ray examination, may be found to be comparatively slight at the operation.

It is possible that the friction of food against the mucous membrane, as it passes through the narrow neck of a spasmodic hour-glass stomach, may cause abrasions, which form the starting-point of chronic ulcers when the spasm is due to some non-gastric condition. When the spasm is produced by an acute ulcer, the friction may help to convert it into a chronic ulcer. It is thus possible that an hour-glass stomach, which is at first functional and due to a spasm, may eventually be organic and due to a chronic ulcer.

II.—ORTHOSTATIC HOUR-GLASS STOMACH

The most common condition which has led to mistakes in diagnosis is a result of the co-existence of severe atony with gastropnoia. As it is only present when the patient is in the erect position, we have called the condition "orthostatic hour-glass stomach."

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When a stomach with normal muscular tone is examined with the x-rays in the vertical position, the upper limit of its contents is found to remain at a constant height whatever the quantity of food present. This is due to the tone of the muscular coat adapting itself to the volume of the contents in such a way that the intra-gastric pressure remains constant. It is naturally not affected by the position of the stomach. Consequently in gastropotosis the stomach forms a tubular organ, the whole of which is filled with the mixture of food and gastric juice, except part of the fundus which contains gas; some narrowing is generally present in the centre of the body (Fig. 4).

A dropped stomach, the tone of which is deficient, acts in a very different manner. Its walls do not contract upon the gastric contents, so that the food falls at once to the most

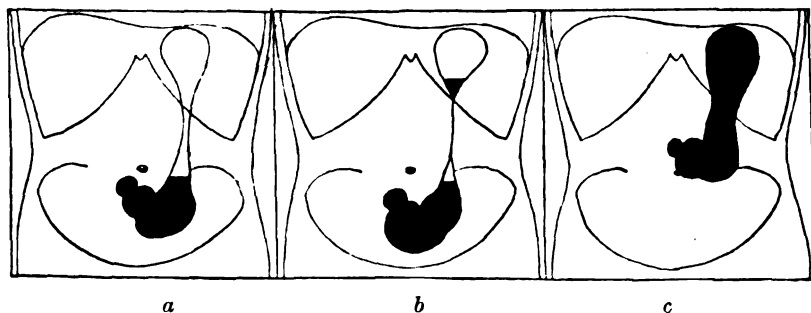
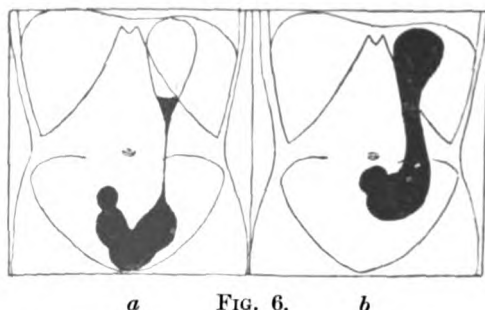


FIG. 5.

Orthostatic hour-glass stomach: *a*, vertical position, first stage; *b*, vertical position, second stage; *c*, horizontal position.

dependent part of the organ (Fig. 5, *a*), which sags more and more as the quantity of food present increases. The upper limit of the gastric contents is therefore abnormally low, and only rises slowly as additional food enters the stomach. The fundus being fixed, the food and gastric secretion in the most dependent part of the stomach exert a considerable tension upon its body, which becomes more and more stretched. The passage between the fundus and the dependent part of the stomach becomes narrower and narrower, until finally its lumen is completely obliterated, the stomach being now divided into an upper segment and a lower and much larger segment containing the food and a small quantity of gas. If more food is now swallowed it remains in the upper part of the stomach (Fig. 5, *b*), and small quantities can be seen periodically passing through the neck to join the main portion of the gastric contents. This hour-glass condition of course disappears immedi-

ately the patient lies down (Fig. 5, c, and Fig. 6). A mistake in diagnosis in such a case would never be made if all patients with suspected hour-glass stomach were examined lying down as well as standing up. There was at one time an unfortunate tendency to examine the stomach with the x-rays in the vertical position only. Many observers only examined the patient when the whole opaque meal had been swallowed, or at the beginning of the meal and again at the end. In such circumstances the hour-glass condition seen in Fig. 5, b, would be discovered, but the manner in which it develops would be missed. In order to avoid mistaking this functional hour-glass stomach for an organic condition, it is therefore necessary to examine the patient at short intervals whilst the meal is being taken. In most cases the hour-glass condition disappears if



Orthostatic hour-glass stomach: (a) standing; (b) lying; splashing was felt in the left iliac fossa five hours after a breakfast of tea and toast.

the patient contracts his abdominal muscles or pressure is exerted on the lower part of the abdomen. Occasionally, however, the ptosis is so extreme that the lower segment of the stomach is further depressed instead of raised by this means (Fig. 7).

We have already referred to an important characteristic in the appearance of both spasmodic and orthostatic hour-glass stomachs, by means of which they can be distinguished from the organic condition. The upper portion of the stomach is conical in shape, and tapers below to a point from which the food can be seen to pass at intervals through the narrow neck into the lower portion of the stomach. When the hour-glass constriction is organic, the upper division of the stomach is not conical, and part of it almost invariably sags below and to the left of the entrance to the constriction (Fig. 8), as was first pointed out by Cerné and Delaforge¹³ and is now generally recognised.

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An organic hour-glass constriction is often rendered more complete owing to the sagging of both segments, which results

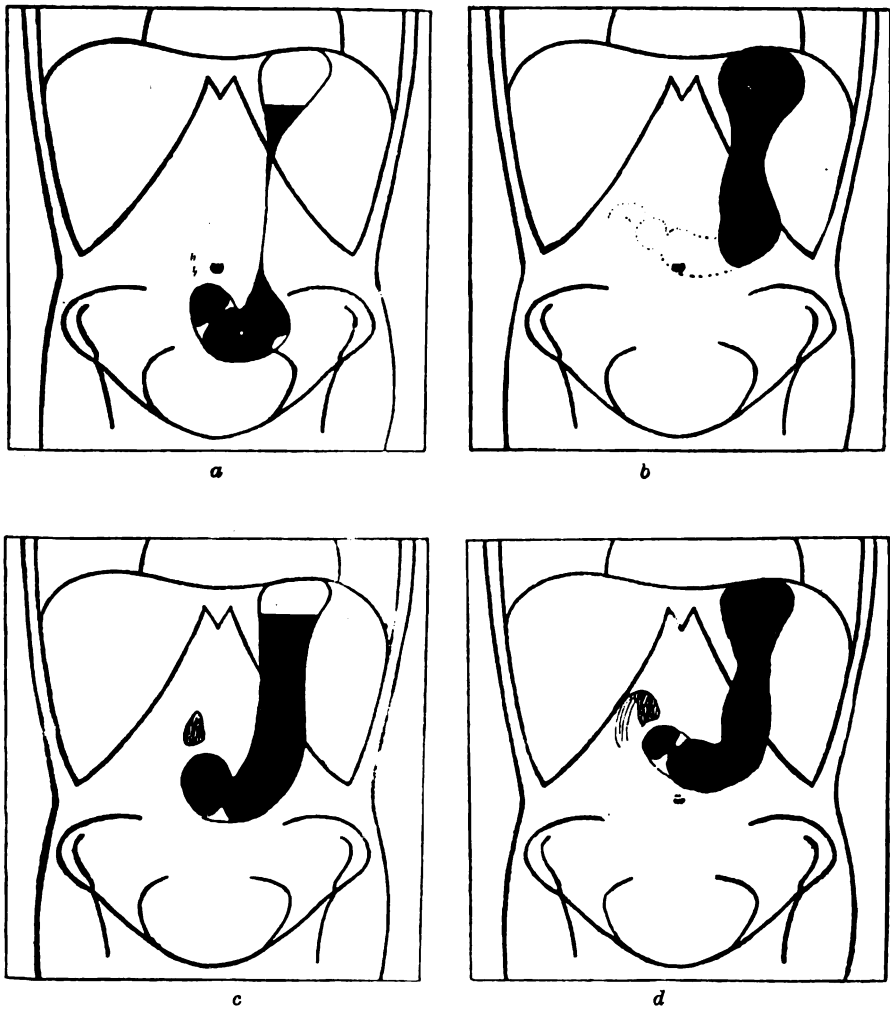


FIG. 7.

Orthostatic hour-glass stomach, with extreme stasis in erect position, due to duodenal kink, cured by six weeks' treatment in bed, and maintained six months later: *a*, vertical, before treatment (Nov., 1912); *b*, horizontal, before treatment (Nov., 1912), only emptied when lying on right side—shown dotted; *c*, vertical, after treatment (June, 1913); *d*, horizontal, after treatment (June, 1913).

from gravity when the erect position is assumed. This explains the relief obtained by lying down in such cases as that from which Fig. 8 was traced.

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It is possible that the friction of food passing through the narrow neck of an orthostatic hour-glass stomach may have the same effect as in spasmodic hour-glass stomach, so that a chronic ulcer may form when the patient is predisposed by the presence of the other factors necessary for the formation of an ulcer. The fact that the combination of atony and ptosis, which leads to the production of an orthostatic hour-glass stomach, is much more common in women than in men may be one reason why the large majority of cases of organic hour-glass stomach occur in women.

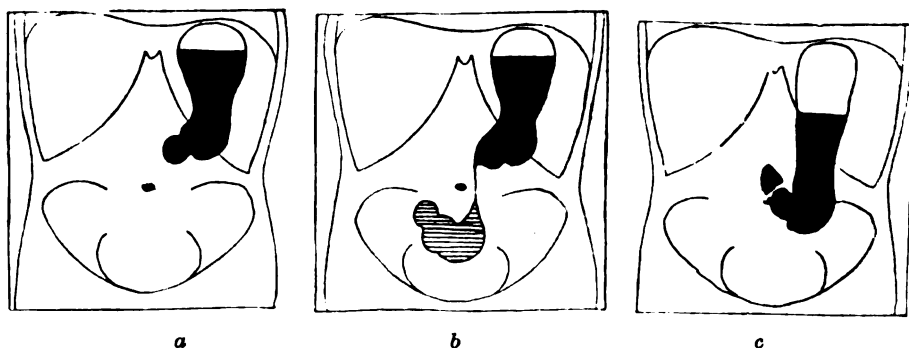


FIG. 8.

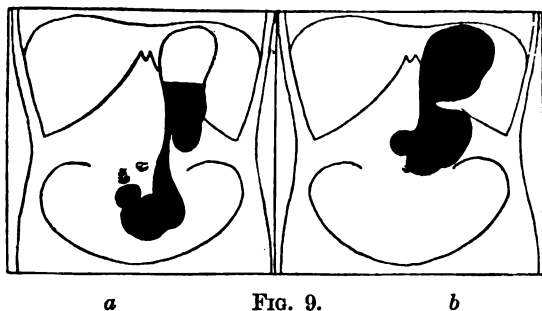
Hour-glass stomach, due to cicatrization of a gastric ulcer: *a*, half an hour after opaque meal; *b*, six hours after opaque meal; *c*, three weeks after gastro-gastrostomy.

III.—FUNCTIONAL HOUR-GLASS STOMACH DUE TO ADHESIONS

A third form of functional hour-glass stomach may result from the presence of an ulcer on the lesser curvature adherent to the left lobe of the liver. When the patient stands, the stomach tends to assume a vertical position. The ulcer being fixed to the liver, a line of tension is produced diagonally across the stomach. The greater curvature is held up at the point where the line of tension meets it, and the part of the stomach immediately above tends to sag down, an appearance of hour-glass stomach being produced, although no constriction or only a slight one exists (Fig. 9). This condition sometimes resembles organic hour-glass stomach even more closely than the functional forms already described, as part of the upper segment may sag below and to the left of the neck. But, as in the case of orthostatic hour-glass stomach, the constriction disappears on lying down.

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In conclusion, it is necessary to direct attention to the fact that cases of extreme organic hour-glass contraction not only give none of the physical signs, which are sometimes present



Hour-glass stomach, due to treated ulcer of twenty-five years' standing :
a, standing; *b*, lying. Complete relief after gastro-gastrostomy.

in the slighter forms, but are very likely to be missed with the x-rays, unless the examination is carried out with special care. When the opaque meal has been taken the upper division of

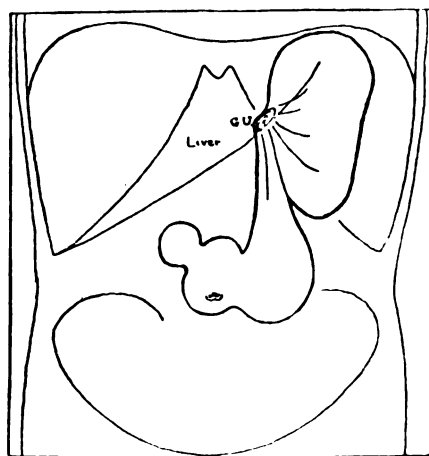


FIG. 10.

Functional (and orthostatic) hour-glass stomach, due to adhesions of a gastric ulcer (G.U.) to the liver.

the stomach is clearly visible in the vertical position, but its lowermost point does not reach the level of the umbilicus, and in several of our cases did not extend below the left costal margin (Fig. 18, *a*). When the history and symptoms of the patient

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point to pyloric obstruction and the stomach is found to be very small instead of large, a tight hour-glass stricture should at once be suspected. The stricture may be so narrow that nothing passes through it during the initial examination, and



FIG. 11.

Skiagram of organic hour-glass stomach without active ulceration,
by Dr. P. Briggs.

even an hour later nothing but the upper segment of the stomach may be visible. In such cases it is necessary to examine the patient a second time about six hours after the barium meal. By this time sufficient barium will have reached the lower segment of the stomach for it to be visible, and in some cases

a fine line can be seen joining the two segments together (Fig. 10, b). If pyloric obstruction co-exists with an hour-glass contraction, the lower segment of the stomach is clearly seen. When the pylorus is unaffected, the pyloric canal being wider than the passage between the two parts of the stomach, the food which slowly enters the distal part leaves it at once, so that very little of the opaque meal accumulates in the latter. Consequently the shadow of the lower division of the stomach is always faint compared with that of the upper division, and it may be overlooked or mistaken for intestine, unless these facts are borne in mind.

The presence of a minute diverticulum at the level of the constriction and almost invariably on its inner side proves that an active ulcer is present, as it represents the crater of the ulcer, which is partly filled with some of the opaque meal; occasionally a gas bubble is visible above it. The ulcer is also always found to be tender if deep pressure is applied to it under the screen, when its exact position is defined with the x-rays.

TREATMENT

Although medical treatment may greatly relieve the symptoms of hour-glass stomach in its early stages, an operation should be performed as soon as the diagnosis has been made, as it is rarely possible to cause the ulcer to heal completely, and in the process of partial healing under medical treatment the inevitable contraction of the scar leads to increasing obstruction, whilst in less favourable cases the ulcer may recur, spread, or even become malignant.

In rare cases after an ulcer has healed the patient remains quite comfortable so long as he is careful with his diet, in spite of having a well-marked hour-glass contraction of the stomach. In such cases operation is not essential, although a gastro-gastrostomy would enable the patient to eat ordinary food. A woman of fifty-five had symptoms of gastric ulcer, which apparently became quiescent about fourteen years ago. For the last thirteen years she has lived on milk foods, eggs, bread-and-butter and a small quantity of fish. So long as she took nothing else she remained perfectly comfortable, but the slightest excess led to vomiting about four hours after taking the food. Investigation showed that she had a well-marked hour-glass stomach (Fig. 11), but there was no clinical or radiological evidence of active ulceration. No occult blood was present in the gastric contents or fæces, and the acidity was normal. On the question being put to her she decided that she

preferred to go on as she had been doing in the past with a careful diet, rather than submit to operation.

The patient should be carefully prepared for the operation; the stomach is washed out if there is much stasis, and after this the diet should be limited to sterile liquids for two days before the operation. Rectal salines may also be given with advantage in severe cases. Any septic foci in the mouth should be dealt with before the operation.

The operation should begin as a rapid exploration of the whole abdomen, and any obvious source of infection—such as a diseased appendix—treated. The stomach, pylorus and duodenum must be carefully examined, for, without this pre-

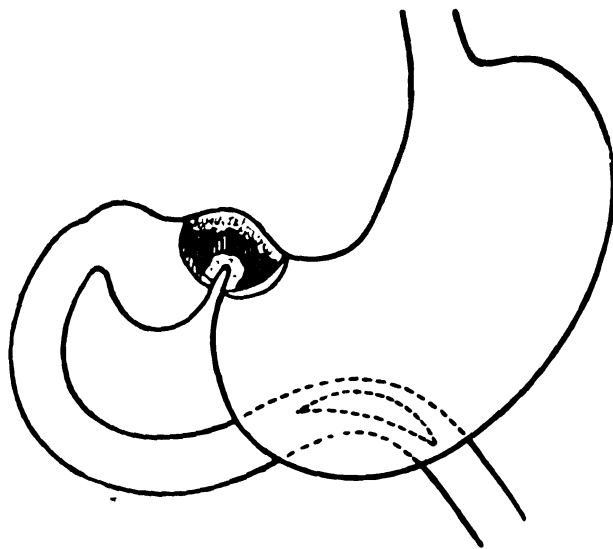


FIG. 12.

Simple ulcer; small pyloric pouch; tetany; gastro-jejunostomy.

caution, a cardiac pouch, a trilocular stomach or associated pyloric or duodenal obstruction has been overlooked, with disastrous consequences. In six cases mentioned by Veyrassat,¹⁴ the pyloric pouch alone was drained by a gastro-jejunostomy with fatal results.

The exact nature of the operation must depend on the conditions found on exploration, for the same operation is not suitable for all cases. Much depends on the size of the cardiac pouch, the presence or absence of pyloric obstruction or adhesions, and any suspicion of malignant disease. The condition of the patient has also to be taken into consideration, for this is frequently too bad for a long and severe operation.

The immediate need is to overcome the obstruction so that

the patient may be saved from starvation. Under these conditions excision, which may appear the ideal radical operation, may be far too dangerous and therefore wrong. Experience has also shown that it is rarely necessary.

Hour-glass contraction depends chiefly on the formation of scar tissue in connection with a chronic ulcer. Recovery under medical treatment is prevented by the increasing obstruction with the consequent starvation, and the forcing of food through the narrow neck of the hour-glass over the surface of the ulcer. When the obstruction is overcome by operation, the food no longer passes over the ulcer, full diet can be taken with safety, and complete healing may be expected; there is abundant evidence that this does in fact take place.

The surgery of simple and malignant hour-glass contraction will be considered separately.

[1. *Simple Hour-glass Contraction*.—One or more of the following may be required :

- (1) Gastro-gastrostomy.
- (2) Gastro-jejunostomy, posterior or anterior, single or double.
- (3) Gastroplasty.
- (4) Excision of the ulcer.
- (5) Excision of the stricture.
- (6) Partial gastrectomy.
- (7) Retrograde dilatation.
- (8) Jejunostomy.

The choice of operation depends chiefly on the presence or absence of pyloric obstruction in addition to hour-glass contraction. It follows that the discussion will be greatly facilitated by adopting this natural division.

[(a) *Hour-glass Contraction without Pyloric Stenosis*.—When there is no pyloric obstruction and the cardiac pouch is of a good size, posterior gastro-jejunostomy (Fig. 12), engaging the lower part of the cardiac pouch, is attractive, because it not only overcomes the mid-gastric stricture in a simple and safe way, but it also permanently corrects the hypersecretion of the gastric juice, which is such an important cause of the persistence of the ulceration when a stricture has once formed. This hypersecretion, if unchecked, may not only delay the healing of the ulcer at the stricture, but may contribute to the formation of a new ulcer in the proximal sac. This actually happened in one of our early cases, a gastric ulcer developing on the lesser curvature above the old stricture, which had been overcome by gastro-gastrostomy. A secondary posterior gastro-

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jejunostomy completely relieved the symptoms, and the patient has remained well for eight years.

When the cardiac pouch is small, posterior gastro-jejunostomy is not only difficult, but the unusual position of the stoma, especially as regards the jejunum, makes vicious vomiting unusually likely to follow. In one of our cases this had to be corrected by entero-anastomosis a year later.

Extensive adhesions on the posterior wall of the stomach, or a very small, inelastic cardiac pouch may make posterior

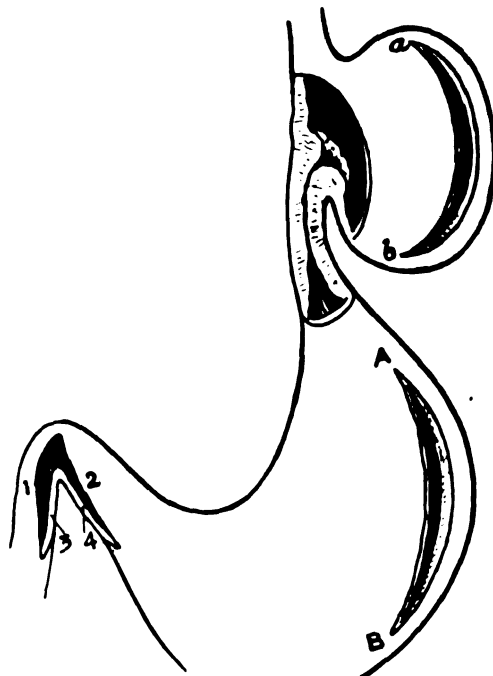


FIG. 13.

Gastro-gastrostomy and Finney's operation: *A* was joined to *b*, *a* to *B*; 1 to 2, and 3 to 4.

gastro-jejunostomy difficult or impossible. In this case either gastro-gastrostomy (Fig. 13), or anterior gastro-jejunostomy, engaging the cardiac pouch, must be performed; of the two the former is the better operation.

Gastro-gastrostomy is, as a rule, the most satisfactory operation, for, when well done, it effectively and permanently removes the obstruction without altering the physiological conditions of the stomach (Fig. 8), and without trespassing on the ulcerated stricture, through which the food probably never again passes. Moreover, it is a very safe operation, and it carries no risk of gastro-jejunal or jejunal ulcer or vicious vomiting,

which is especially likely to follow gastro-jejunostomy performed under unusual difficulties.

When the upper pouch is very small gastro-gastrostomy may be difficult, but by making a curved incision a sufficiently large opening can be obtained. The vertical gastric incision figured in some of the books cannot be made nearly long enough to provide adequate drainage (Figs. 13 and 17). This operation is much more easily done on the front of the stomach, for adhesions in the lesser sac and the distortion of the stomach

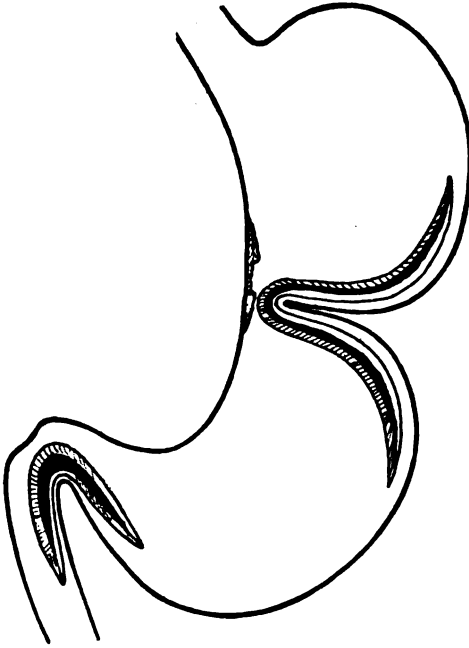


FIG. 14.

Gastro-plasty and Finney's pyloro-plasty. The strictures are overcome by sewing the edges of the wounds properly.

make a posterior operation very difficult without any compensating advantages.

In some cases a gastro-jejunostomy, in which the jejunum is joined to the lower border of both pouches, has been added to the gastro-gastrostomy with the object of gaining the advantages of both operations, while avoiding some of their disadvantages.

Gastro-plasty, as advocated by Kammerer (Fig. 14), is not nearly such a satisfactory operation, for by it the stricture and the ulcer, which is practically always present, are laid open, hæmorrhage is more likely to follow, and the sewing is more difficult owing to the adhesions which generally bind down the

contracted part of the stomach. Inseparable adhesions to the liver or pancreas, especially if the ulcer is near the cardia, make gastro-plasty difficult and too dangerous, for some of the sewing has to be done very deeply in the epigastrium under cover of the left costal margin.

In some cases it is possible and advisable to excise the ulcer upon the lesser curvature (Fig. 15) without approaching too near the greater curvature. When the V-shaped opening thus made is closed, the narrowing is abolished and the natural shape of the stomach is restored. This operation has the merit of immediately removing a chronic ulcer, which is slow to heal and may be regarded as a possible source of malignant disease, but it is unnecessarily difficult and severe for bad cases, and is

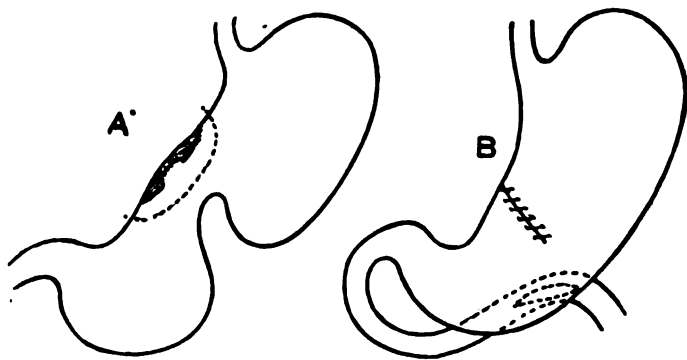


FIG. 15.

The ulcer is excised A, and the opening closed as in B. Sometimes posterior gastro-jejunostomy is also done as in B.

only to be undertaken at any time by surgeons of considerable skill and experience in gastric surgery. It must be remembered always that gastro-gastrostomy, which is a comparatively easy operation, nearly always cures these patients at a very small risk.

Removal of the part of the stomach bearing the stricture (sleeve resection) (Fig. 16) has been very strongly recommended by some surgeons, but it is usually unnecessarily severe for simple ulcers and it exposes a feeble patient to undue risk. For malignant disease it is not extensive enough to be radical.

Moynihan⁶ records a remarkable case, in which it was impossible to join the cardiac to the pyloric pouch or jejunum, owing to adhesions. He opened the pyloric pouch and dilated the stricture in a retrograde manner and, to his surprise, the patient made a good recovery. We once found an ulcer close to and involving the cardiac orifice, causing hour-glass con-

traction and œsophageal obstruction (Fig. 17). The very small cardiac pouch was anastomosed to the pyloric pouch and the cardiac orifice was dilated. The patient died some

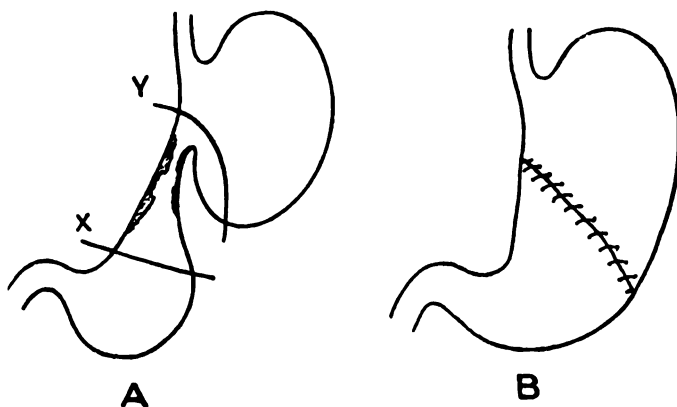


FIG. 16.

Resection of the stricture with end to end union. The part between X and Y is removed.

months later from recurrence of the œsophageal stricture, which was unfortunately not treated by bougies. Adhesions made it quite impossible to anastomose the œsophagus to the cardiac pouch in this very feeble, emaciated patient.



FIG. 17.

Very high hour-glass contraction with obstruction at the cardiac orifice. The curved wound X was joined to Y.

Temporary jejunostomy has been performed in some cases when no other operation could be done with advantage (Eusterman²). The rest afforded to the stomach for some months may improve the local conditions so much that a secondary radical gastric operation may become practical.

GASTRO-GASTROSTOMY

The essential points of gastro-gastrostomy—the operation most needed for the relief of hour-glass contraction of the stomach—now require attention. It is of vital importance to make the stoma as large as possible, especially when this is the only operation performed. With this object very large pouches of the cardiac and pyloric parts of the stomach are so secured in strong, curved clamps that a long curved incision can be made in them about one inch above and nearly parallel to the greater curvature. The points of the clamps are just below and in front of the stricture and their handles below on

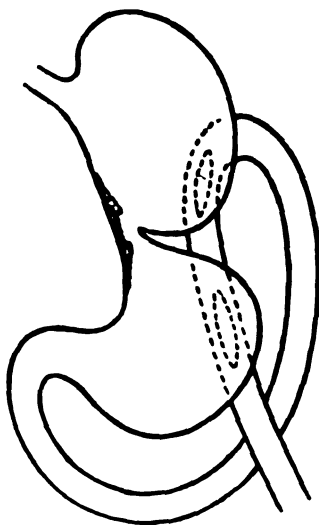


FIG. 18.

Double posterior gastro-jejunostomy.

the greater curvature well to the right and left. The pouches are brought together and joined by two layers of No. 00 formalin catgut sutures as in gastro-jejunostomy.

(b) *Hour-glass Contraction with Pyloric or Duodenal stenosis.*—When the pylorus is movable Finney's operation of gastro-duodenostomy (Figs. 13 and 14), appears to be the best method of overcoming the associated pyloric stenosis, for it can be performed in far less time, when time is important in these enfeebled patients requiring two anastomoses, and particularly because it carries no risk of vicious circle or gastro-jejunal ulcer. It may be objected that Finney's operation does not drain the stomach as well as gastro-jejunostomy, but this depends largely on the size of the opening, which can be made very large by

Finney's method. It is possible that gastro-jejunostomy, by allowing more bile and pancreatic juice to reach the stomach to neutralise the gastric juice, is a surer safeguard against recurrence of ulceration in the stomach. It is certainly considerably better and easier when there is active ulceration or extensive adhesion at the pylorus.

When the pylorus is fixed or ulcerated the ideal operation seems to be a single posterior gastro-jejunostomy added to gastrectomy, the jejunum being joined to the pyloric pouch.

Double posterior gastro-jejunostomy (Fig. 18) is not satisfactory under these circumstances for various reasons. It is difficult to drain the two pouches thoroughly through the limited space available in the mesocolon. Moreover, there are

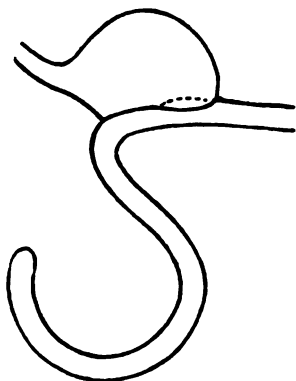


FIG. 19.
Partial gastrectomy.

as a rule extensive and firm adhesions behind the stomach, and the mesocolon may be considerably shortened and adherent. In some of our cases it seemed quite impossible to join the jejunum to the posterior surface of the very small cardiac pouch, without undue risk of angulation and obstruction of the long drawn-up loop of the jejunum, around which the mesocolon, although sewn to the stomach, is very likely to contract.

Double anterior gastro-jejunostomy is an alternative we have never thought worth trying, judging from the comparatively poor results of this operation for pyloric obstruction. It is well known that gastro-jejunal ulcer and vicious circle are unduly common after it.

2. *Malignant Hour-glass Contraction*.—It is not always easy to say whether hour-glass contraction is innocent or malignant. There is plenty of evidence to show that carcinoma may super-

190 HOUR-GLASS CONTRACTION OF STOMACH

vene upon a simple ulcer of the stomach, and it is clear that the early stages of the malignant change are difficult or impossible to recognise at the operation.

Cancer may be suspected if the ulcer base is unusually thick and hard and its edges hard and raised, if the glands in the lesser curvature are hard and considerably enlarged, or if any nodules are seen on the peritoneum covering the ulcer.

If there is a reasonable suspicion of cancer and the patient's

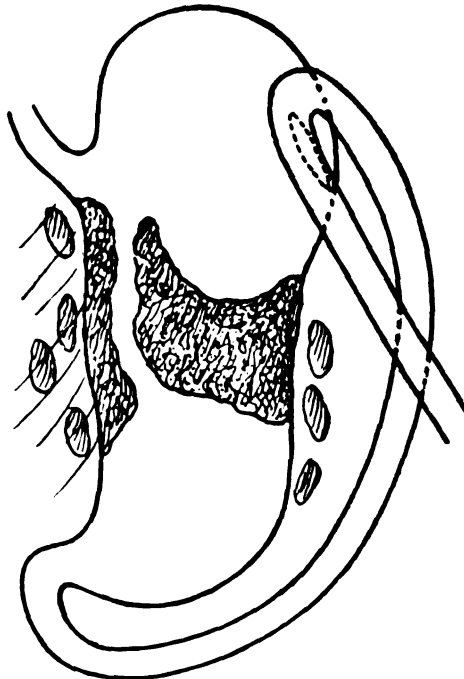


FIG. 20.

Anterior gastro-jejunostomy for irremovable carcinoma causing hour-glass contraction.

condition is fairly good, partial gastrectomy should be performed, the duodenum closed and the jejunum joined to the open end of the cardiac pouch in front of the colon after the Polya-Mayo method (Fig. 19).

When the growth is irremovable, a gastro-jejunostomy should, if possible, be performed, for this overcomes the obstruction and gives relief for some time. It is rarely practicable to perform the posterior operation, but an anterior anastomosis engaging the cardiac pouch high up and well to the left of the obstruction, is satisfactory and well worth doing (Fig. 20). It prolonged the life and relieved the obstructive

symptoms of one of our patients for nearly two years and of another for six months. In a few instances a jejunostomy may be preferable.

RESULTS OF OPERATION

Mortality.—Veyrassat's¹⁴ statistics published in 1908 show a mortality of 16 per cent. for 260 operations for simple hourglass stomach, but six of the deaths were due to draining the pyloric instead of the cardiac pouch. The death-rate has much diminished since then. One of us (R. P. R.) has operated on over twenty cases without a death due to the operation. One patient died from accidental suffocation soon after the operation.

Ultimate Results.—These are very good if free drainage is provided. We have been able to trace nearly all our patients, though a few have changed their addresses during the war. They are invariably very pleased with the results of the operation. The following letter is typical of many: "I am very pleased to be able to write and let you know I have enjoyed wonderful good health ever since my operation which was done eight years ago this month. It must have been the making of me. My life was a misery before that for years. Five times I had been in hospital two and three months at a time, as well as out-patient but now I have enjoyed the best of health ever since, can eat and drink anything without any pain after, whereas before I could not take even soda and milk and I thank you very much for the wonderful operation you performed on me to be able to enjoy life so well as I have been able to. I also had two Cæsarian Operations in the same Hospital (Guy's), done by Dr. Horrocks, and the two boys have grown fine boys indeed, one nearly fifteen the other nearly thirteen years of age."

A second operation had to be performed for recurrence of gastric symptoms on two occasions. Once a new ulcer had formed higher up on the lesser curvature after gastro-gastrostomy. Gastro-jejunostomy was performed and the patient has remained well for eight years. In the other case a chronic vicious circle developed and was relieved by entero-enterostomy a year later. The posterior gastro-jejunostomy had engaged a small cardiac pouch, the stoma being too high and too far to the left, causing kinking of the jejunum.

CONCLUSIONS

(1) Hour-glass stomach is nearly always due to contraction of a chronic ulcer on the lesser curvature of the stomach.

(2) It gives rise to the characteristic symptoms of lesser curvature ulcer, to which are gradually added those of obstruction.

(3) The diagnosis can only be established with certainty by radiography.

(4) The most suitable operation must be decided upon when the abdomen has been opened.

(5) Gastro-gastrostomy with a large opening is the simplest, safest and best operation in the majority of cases, but, if the cardiac pouch is large, gastro-jejunostomy is preferable.

(6) When pyloric stenosis co-exists, either Finney's operation or posterior gastro-jejunostomy has to be performed in addition to gastro-gastrostomy.

(7) If there is any suspicion of malignant disease, partial gastrectomy should, if possible, be performed.

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NOTES REGARDING THE PATHOLOGICAL EFFECTS OF THE VISIBLE AND INVISIBLE SPECTRUM ON THE EYE

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THE problem of illumination viewed from a medical and practical standpoint is now occupying the attention of numerous sub-committees, and questions regarding glare from motor lamps, glare on the eyes of cinema artistes during the production of films, the experiences of mountaineers, Arctic and Antarctic explorers, of the condition known as snow-blindness, and various occupational troubles resulting from such trades as glass-blowing, electric welding, etc., have drawn ophthalmologists to consider what are the effects on the eye of the various forms of radiant energy.

The one factor common to all the different energies comprised in the visible and invisible spectrum seems to be a uniform speed of transmission through the ether of space, viz., 186,000 miles per second. X-rays, ultra-violet rays, light, heat, infra-red, wireless telegraphic rays, magnetic disturbances, all travel through space at the same speed.

100μ	Invisible.	400μ	Visible.	700μ	Invisible.	2300μ
X-rays.						Hertzian Waves.
	Ultra-violet. Actinic.	Violet.	Indigo. Blue. Green. Yellow.	Orange. Red.	Infra-red. Heat.	

DIAGRAM OF ETHER WAVES

On the other hand, they all differ in the length and rapidity of their vibrations, the longest and consequently the least rapid of these being those used in wireless telegraphy, and the shortest and most rapid the x-rays, the difference in the wave-lengths lying between several furlongs and 100μ . * Remembering that energy transmitted through a substance

* A micromillimetre (μ) is the millionth of a millimetre.

does no work upon it, work only resulting when absorption takes place, we may note that, as far as we know, the tissues of the eye are affected only by rays between wave-lengths of $295\ \mu\mu$ and $2800\ \mu\mu$.

It must not be supposed that the physiological or pathological effects of these rays are as definite as their physical properties. Heat rays in their pathological effect overlap light rays, and light rays in their turn overlap the actinic or chemical rays at the short end of the spectrum, and although it may be possible mathematically to set out a perfect sequence of these rays, this is not possible either physiologically or pathologically. In order to render description easier we may divide the more important of these rays into three large groups,—(1) the ultra-violet rays (invisible), (2) the light rays (visible) and (3) the infra-red rays (invisible). The infra-red rays can be rendered visible by phosphorescence, and the ultra-violet by fluorescence, so that all can be examined by means of vision.

(1) Of the vibrations that affect the ocular tissues the ultra-violet rays are absorbed by the conjunctiva, cornea and lens, for it has been found that the cornea absorbs all rays shorter than $300\ \mu\mu$, and the lens all shorter than $400\ \mu\mu$. The fact that the vitreous also absorbs ultra-violet rays is not of great importance, since these will have been dealt with by the cornea and lens before they can reach the vitreous.

(2) We may consider the visible spectrum to lie between wave-lengths of 400 and $700\ \mu\mu$. The transparent media of the eye are uniformly permeable to these rays, so that light passing through the pupil produces definite effects only on reaching the retinal pigment. The iris and uveal tract absorb almost all luminous rays, but not all, as perception of light is still possible if the cornea has been destroyed, and we can transilluminate the globe through the sclera.

(3) Of the infra-red rays (from 700 to $2000\ \mu\mu$), which include the heat rays, a proportion reach the retina, about 12 per cent. being stopped by the lens. Of those that reach the retina, the majority are absorbed by the retinal and choroidal pigment, but a small number actually reach the orbit behind the globe. Generally speaking, there is a continuous loss of heat during transmission through the various media of the eye owing to reflection at the different surfaces and absorption by the various media.

The repeated query "Is electric light bad for the eyes?" calls for an answer, as convincing evidence would need to be forthcoming to deter people from using anything so universally convenient.

EFFECTS OF ARTIFICIAL LIGHT

Modern artificial light is very largely obtained by passing an electric current through a fine filament, made of the infusible and non-volatile elements tungsten (Osram), tantalum, carbon or osmium. The spectrum of this incandescent light is similar to that of petroleum and gaslight, which are the alternative sources of artificial light in general use. On comparing the spectra of these various forms of light, however, we find that an osmium or a tantalum lamp has a spectrum ranging from 800 to 680 $\mu\mu$, a naked arc lamp 280 to 600 $\mu\mu$, and a petroleum lamp from 350 to 600 $\mu\mu$. The spectrum, therefore, of a petroleum lamp contains fewer ultra-violet rays than an ordinary electric lamp and far less than the arc lamp or the sun; consequently, as a source of illumination it has less chemical activity but also far less luminous efficiency.

Light which contains an excess of ultra-violet rays is more irritating to the eyes than light consisting of visible light rays only, and naked arc lamps, when being tested photometrically, produce definite pathological effects upon the eyes of those carrying out the experiments and exposed to their influence. Finsen and his assistants in their earlier experiments suffered from red, tender, swollen eyelids, and conjunctivitis. The ultra-violet rays are of intense chemical activity, and it is these rays which produce the symptoms associated with electric light conjunctivitis, either by stimulating the nerve ends in the conjunctiva or by some direct chemical irritation of that membrane.

The consensus of opinion would indicate that in electric light we have an illumination that is capable of greater injury to the eye than gas, and very much greater than that of an oil lamp. In incandescent lamps used for house-illumination there is an irritating effect from long-continued exposure to the visible chemical rays; an oil lamp is less rich in actinic rays and gives a yellower and softer light.

SNOW-BLINDNESS

In the phenomena of snow-blindness we have a much more conclusive demonstration of these pathological effects. Recently I have been fortunate enough to have as a patient a young officer, *æt.* 31, who has been a member of a Canadian Arctic expedition visiting the Beaufort Sea, Amundsen's Gulf, and the Parry Archipelago. He came to me for advice on the subject of his own eyes, and their protection from snow-blindness during any similar expedition in the future.

On examination I obtained the following results :—

V. R. E. 6/9; $\bar{c} + \cdot 5$ Vert. = 6 5

V. L. E. 6/6; $\bar{c} + \cdot 5$ D. Cyl. Axis down and in $70^\circ = 6\frac{1}{5}$,

with one diopter of manifest hypermetropia.

He kindly wrote for me an account of his experience, and I append it very much in his own words.

The conditions in which one is most likely to become snow-blind are those of mist or fog in the early spring in snow-covered regions, to a less extent in the thawing months of spring, and still less during the first few weeks of the autumn.

Snow-blindness is never experienced in extremely low temperatures, say below 10° F., and seldom at freezing-point, but generally in a condition of fog-haze or "white-darkness," when all sense of perspective and stereoscopic vision is lost, and the light is one of absolute evenness without shade or tone. It is rarely, if ever, experienced in late spring, when projecting dark objects are free from snow, or in the fall before all objects are completely snow-covered.

Bright sunlight affects the eyes in a different manner, and real blindness, so far as our experience went, was never the result of bright, glaring sunlight and shadow.

Symptoms.—The eyes are bloodshot and slightly inflamed. In six hours the lids feel as if sand and grit had lodged in them and the eyes "water." In twelve hours the "grittiness" is felt all over the eyes and also a desire to keep the eyes shut and apply pressure to the lids; there is a discharge of clear, slightly viscous liquid from the eyes and nose. Pain may be severe, and any attempt to open the eyes increases it and augments the discharge. The upper nasal chambers feel stuffed, as with the early symptoms of a cold. In twenty-four hours the local pain is intense, and it feels as though thousands of red-hot needles were being forced through the eyes to the sockets. One has a throbbing headache and a sensation of rawness in the nose. Any local muscular effort to move the eyes or swollen eyelids increases the pain. The lids once parted with the fingers remain in any position in which they are put. The eyeballs and lining of the lids are covered with a greyish film, through which the iris and pupils are just discernible. Nothing can be distinctly seen even with the eyes held open, but one recognises a difference of light intensity similar to what one feels if a light is switched on when the eyes are closed.

At the first noticeable symptoms, the eyes are protected by bandages, the inflammation reaches its highest

point and the discharge is greatest in twenty-four hours. In thirty-six hours there is a noticeable improvement without any local treatment, and the greyish film disappears. In forty-eight hours the patient can bear subdued light with his eyes open, and can move about if coloured glasses or dark glasses are worn. In seventy-two hours the eyes are practically normal, but with a tendency to relapse if unfavourable conditions are met with.

When travelling alone or leading a party, one of necessity removes or entirely neglects eye-protectors, such as coloured glasses, slotted spectacles, etc., for short periods, and after about two hours' travelling under these conditions, one feels a tendency to muscular contraction as in squinting. After four hours' total exposure there is a "dryness" of the eyes and irritation, and vision is more or less indistinct. Fixed objects have a tendency to float in the field of vision. If at this stage the eyes are protected from the light, serious inconvenience is generally avoided. There is the usual discharge and partial paralysis, but the greyish film does not form and vision does not become totally impossible.

Slight relief is obtained by steaming the eyes for as long as possible over boiling water or by applying some form of counter-irritant. I have known men scald their faces over boiling kettles, put granulated sugar, molasses, dry tea-leaves, tobacco, or anything else they could find, in their eyes to create distraction from the piercing pain of unadulterated snow-blindness.

The period of intense pain lasts—if the eyes are protected from the light—about ten to twelve hours, then although the local muscles are stiff and slow in motion, it is possible to move them by voluntary effort, and the discharge from the eyes and nose gradually ceases. If at this stage the eyes are again exposed acute symptoms will be experienced afresh. Conditions compelled me at one stage to use my eyes each possible moment I could see, and consequently I endured the blind stage five times in seven days, taking longer to recover from each relapse. The eyes rapidly regain normal vision, but with each attack they are more susceptible.

Methods of prevention.—The use of dark or coloured glasses is sufficient protection, but under practical conditions it was found impossible to keep them always before the eyes. This was chiefly because the condensation of the breath on the glass formed hoar frost, through which one could not see, and the glasses had to be lifted at intervals or taken off to be cleaned. The native type of slotted wooden spectacles was found useful, but not absolutely preventive, in the case of continued exposure.

Any dark object kept continually before the eyes, even if the latter were uncovered, proved preventive, and it was customary to kick before one a dark mitten or glove, or to carry a dark object on the end of a stick before one as one walked.

Susceptibility of the natives.—It was noticed that the natives of the North Country, Amundsen's Gulf, and Parry Archipelago, were by no means immune from attacks of snow-blindness. It might easily be thought that they were, for if you were to question the Eskimos separately it would be found that very few of them had suffered from severe snow-blindness. This would naturally lead one to suppose that they were not susceptible, or that the type of slotted spectacles worn by them was particularly efficient; but after three years' investigation we have come to the conclusion that the Eskimo stays indoors, or at least does not travel on days he would be likely to become snow-blind. People engaged on expedition work cannot afford to waste their time, and consequently must travel under almost all weather conditions, and they consequently suffer.

The Eskimo who has once had an attack usually carries a charm presented by the most influential Angakok or Spirit Doctor he knows, but that is not always so effective as the wooden spectacles he makes for himself from the soft, pine driftwood he finds on the beach, which has been washed to the Arctic shores from the banks of the rivers further south. The wood is curved to fit closely over the bridge of the nose and cover the eyes. It is hollowed out to allow the eyelashes room to move, and horizontal slits are cut, through which to see. The perpendicular vision with these, if the slot is narrow enough to be efficient, is so limited that it causes considerable inconvenience when walking, and one stumbles and stubs one's toes too often to want to use these spectacles frequently for long-distance travelling. They are, however, of service to the Eskimo, who rarely travels more than five miles a day, and that slowly and with frequent rests.

What part of the solar spectrum then is responsible for the sensations experienced by my patient? I think we may exclude the infra-red waves, as those are heat waves and are not likely to be troublesome in the Arctic regions. Again the visible spectrum is clearly not entirely responsible, because you will find that where light is most intense, as, for instance, in the tropics, symptoms such as these are not experienced.

The condition in which one is most likely to become "snow-blind," (a bad term as the victim is not blind), is one of mist or fog in the early spring in Arctic regions, and to a less extent when the snow begins to thaw,—that is to say, during a "fog-

haze," when all sense of perspective is lost and the light is marked by its evenness of shade and tone. When rocks or ground become uncovered and show dark, the condition is less frequently noticed. The leader of the party is more likely to suffer than those following.

The following quotation from Captain Scott's book emphasises this: "In the afternoon my eyes gave out, and I put bandages on the right eye, and gave up the lead to Debenham. It was an astonishing relief to cease from staring at the glaring surface, and either pull along with shut eyes or keep one eye on the gratefully dirty back of Debenham's white woollen jacket."

In the summer there is no complaint of "snow-blindness" amongst ordinary Swiss tourists, although the brilliance of the light is greater than in winter, but in the winter the eyes are exposed while daylight lasts to glare from the surface of the ice and snow. Sunlight contains many ultra-violet rays at the top of mountains, and also some wherever the air is clear as at sea, clean water vapour not being very opaque to them. But the thinnest veil of smoke or other foreign material in the air cuts off the whole of the ultra-violet region, letting the heat rays through undisturbed,—in fact, even helping to entrap them. For these reasons sunlight in or near towns has very little chemical activity. There is enough to affect sensitive photographic plates, but not enough for bleaching or other chemical purposes, nor is there sufficient for bronzing the skin or the destruction of bacteria. In the country, on the other hand, the ultra-violet element which reaches the earth's surface produces physiological effects which are as a rule attributed to ozone.

A certain amount of confusion regarding the cause of snow-blindness is bound to remain so long as it is not definitely settled whether or not retinal lesions are to be found among the symptoms.

If snow-blindness is due to ultra-violet rays alone, then retinal symptoms will be absent or present only as a secondary reflex condition arising out of conjunctival or corneal lesions. Retinal congestion is not uncommon in association with corneal inflammation, but it disappears when the corneal troubles resolve, and it is probable that this is the case in snow-blindness. On the other hand, if definite retinal lesions, scotomata, etc., are to be considered part of the symptoms of this trouble, the luminous rays must be acknowledged to be in part, at any rate, the cause.

We can produce the symptoms of snow-blindness directly. During the war a device was elaborated for signalling at sea,

which consisted of covering a searchlight with a layer of glass, impervious to light rays and pervious only to ultra-violet rays, the message being received on a fluorescent screen. This glass has been made commercially, and can be obtained from any optician. It lets through only a minute amount of red light, but if placed in front of a mercury vapour lamp, it is possible by its fluorescent effect to see quite well various objects placed in its rays. If now one works in these ultra-violet rays, an acute condition of the eyes similar to snow-blindness is set up.

These symptoms then are not due to light, but to the invisible rays at the blue end of the spectrum. The symptoms of snow-blindness are those of a severe conjunctivitis with superficial ulceration of the cornea. It is not confined to human beings only, as Scott and Shackleton both mention that dogs and ponies suffered from it. The ponies' eyes were usually protected by fringes on the bridles.

The contention that the ultra-violet rays are the cause of snow-blindness might be criticised by observing that the solar spectrum extends just as far in London or Paris as in Switzerland or the Arctic regions, and therefore we ought to get snow-blindness in London or Paris; but it has been pointed out that it is not due so much to the quality of the rays as to the quantity, and the rays of short wave-lengths are markedly absorbed by the denser atmosphere. Snow-blindness is analogous to sun-burn, in that it is due to a large extent to the rays of short wave-length.

Most observers do not attribute to these ultra-violet rays any influence on the retina or deep structures of the eye, and retinal symptoms are not amongst those caused by snow-blindness. It is possible that a few of the short rays penetrate the lens, but experimental evidence on this point shows that the cornea and the lens completely absorb all rays shorter than $850\text{ }\mu\mu$, and the visible spectrum commences at about $400\text{ }\mu\mu$, so that very few ultra-violet rays reach the retina at all. The lens would probably require long exposure to ultra-violet rays before becoming affected.

Treatment.—Snow-blindness can generally be prevented provided certain conditions obtain. My patient stated that he was not wearing his glasses. As a practical matter the wearing of glasses by the leader of a polar expedition is not always possible, as in mist, driving snow, etc., the glasses become covered by ice and are rendered opaque. Where the path to be followed is quite safe, and it is only necessary to follow a general direction, the need of clear vision is not urgent, but where a party is being pioneered over unknown regions with crevasses,

snow-drifts, etc., it is absolutely imperative that the leader should see clearly in order to avoid crossing a thin layer of ice covering possibly a deep crevasse, as any want of vision might lead to a serious disaster.

The glass made by Sir William Crookes is more valuable for goggles to prevent "blindness" than the wooden spectacles of the Eskimo, to which my patient referred, as it is so composed that the greatest amount of light and the smallest amount of ultra-violet rays can pass through, and so long as spectacles made of this glass are worn, the irritation from the ultra-violet rays can be combated. If, however, the trouble has developed, astringent lotions and subcutaneous injections of strychnine in the region of the temple, with the instillation of eserine drops should be tried; this was recommended by Dufour of Lausanne, who had experience with this affection amongst Alpinists. Confinement in a dark room and the local application of warm, soothing lotions, and the procuring of sleep give the most speedy and certain results.

Adrenalin and cocaine have been found useful to allay the intense pain, which has been so intense in sufferers on polar expeditions that relief has been sought by strong counter-irritants.

LIGHT RAYS

The luminous rays of the spectrum, roughly speaking those between 400 $\mu\mu$ and 700 $\mu\mu$, are undoubtedly capable of producing pathological effects under certain conditions.

In July 1918 I had two patients suffering from defective vision as a result of having without adequate protection of the eyes studied the eclipse of the sun, which occurred at the end of June of that year. The first case was in a young man, *æt.* 19, who noticed a mist in the centre of his field of vision after prolonged watching of the solar phenomenon through a smoked glass, using his right eye. In the centre of the fundus at the macula was a small square area of intense hyperæmia, with a pale spot in the centre. His vision was reduced to 6/9, and there was a definite central scotoma.

The other case was sent to me a few days later, and was that of a lady; the macula showed a similar ophthalmoscopic appearance and a still larger central scotoma with vision reduced to 6/36.

These and similar lesions have been recorded by a large number of observers. The slighter cases recover; sometimes, however, the scotoma is permanent.

The result that we should expect when light in excessive

amount reaches the retina is supported by clinical evidence, and the luminous rays which are transmitted through the transparent media of the eye produce definite retinal lesions, the retina being the structure where absorption takes place.

The effect of an excessive amount of light reaching the retina is generally called "glare," a term difficult to define, as it cannot be reduced to a mathematical quantity; it is a condition of light which is unpleasant to the eyes and varies in degree in different people.

In ordinary rooms it is found that glare is occasioned not so much by the total amount of light as by its concentration on a small area. Other factors causing glare besides the total amount of light and its concentration or intrinsic brilliancy are the angle at which the light is placed in regard to the visual axis and the size of the illuminating source. It has been computed that the average brightness of the sky approximates to an intrinsic brilliancy of two and a half candles over an area of one inch, and the minimum permissible intrinsic brilliancy for comfort has been fixed at 2 to 3 c.p. to an inch; that is to say, that fatigue is likely to result from a brilliancy of illumination greater than this, when used for reading purposes.

INFRA-RED RAYS

It is now nearly forty years since our attention was drawn to the fact that cataract was proportionately commoner amongst glass-workers than amongst other workers, and that those suffered most whose employment necessitated exposure of their eyes to the intense heat and brilliant illumination of molten glass. These observations have led to an investigation, incomplete, as most of these investigations are, but of a sufficiently conclusive character to suggest that it is the heat rays that produce the changes in the lens, whereby an opacity is formed at a point just in front of the posterior pole. As the intense illumination causes the pupil to contract to a very small point, and as by the refraction of the heat waves the rays are focussed somewhere in that position, it is possible that the formation of the cataract in that particular spot is explained. The cataract, however, does not remain localised, and if the worker persists in this class of work and continues to expose his eyes to the heat and glare of the molten material, the opacities in the lens increase. It appears to take many years for the effect to be produced at all, as it does not occur in men who have only been working for a short time, but the association of cataract with glass-workers has resulted in "glass-workers' cataract" being placed on the list of occupational diseases.

Although the balance of opinion is in favour of the heat rays being the cause of this pathological condition, there are arguments put forward in favour of the possibility of the ultra-violet rays also assisting in the formation of the condition or possibly even being the main cause. It is obvious that the eyes are exposed to the whole range of the visible and invisible spectrum, and it is impossible to differentiate between the effects produced by the different wave-lengths, because, as I have pointed out, the physiological and pathological effects overlap, although the physical differences of the wave-lengths remain distinct.

We may summarise the points in favour of the cataract being due to the infra-red rays, *i. e.* those radiations that lie between wave-lengths of 700 $\mu\mu$ and 2000 $\mu\mu$:—

- (a) the heat waves coming from the molten glass mass are very abundant;
- (b) ultra-violet rays are not in excess, and are, for the most part, absorbed by the cornea before they reach the lens;
- (c) the usual clinical symptoms of ultra-violet irritation are not common in glass-blowers;
- (d) no retinal changes are recorded, as one would expect if the luminous rays were potent.

On the other hand, both ultra-violet rays and infra-red rays will coagulate living and dead proteins, such as white of egg, lens albumen, etc. A cataract can be produced in fish living in solutions of calcium chloride and calcium nitrate by exposing them to a quartz mercury vapour burner, the most effective waves of which lie between 254 and 302 $\mu\mu$. These salts have also been found to be greatly increased in human cataractous lenses, and their presence is necessary for the success of the experiment, as the cataract does not develop if the fish are kept in ordinary tap-water and then exposed to the mercury vapour lamp.

These experiments leave no doubt as to the possibility of lens changes being produced by ultra-violet radiations, and it is suggested that the eyes of glass-workers are subjected to the influence of the short wave-lengths to a greater extent than the average worker in other employments, and that their effect acting over a long period produces a modification of the lens substance, and that when the salts of calcium are present in abnormal amounts, the lens protoplasm turns opaque as a result of the combined influences.

It is interesting to record that the effects of sunburn, which it is now suggested are due not to light but to ultra-violet rays,

are more marked upon the skin when it is wet than when dry, and also that unusual quantities of calcium salts present in the moisture increase the effect of the sunburn.

When one views the lens by ultra-violet rays, it is rendered visible by a fluorescence; experiments show that this fluorescent effect is diminished by weak solutions of calcium salts, dextrose, etc. Further, it is known that fluorescent bacteria are more resistant to the destructive action of ultra-violet radiation than non-fluorescing bacteria. There may, therefore, be some relation between the fluorescing property of the lens and its ability to resist the coagulative effect of ultra-violet radiation.

The late Sir William Crookes carried out a series of investigations on the conditions of glass bottle manufacture. The glass is melted in huge fire-brick tanks heated by incandescent gas, and its temperature is raised to the enormous height of over 2000° F.; the glow and brilliancy of the molten mass has constantly to be faced by those working in this industry. Finishers, "takers in," "wettters off," "gatherers" and blowers, as the workers are called, have during the process of bottle making to take up on rods some of the glass in this highly incandescent and liquid form.

Vogt's experiments on the transmission of heat by the structures of the eye show that far more heat of certain wavelengths gains entrance to the deeper parts of the eye than has hitherto been thought. Heat rays, like ultra-violet rays, submit to the same refractive laws as luminous ones. There is, therefore, a concentration of heat by the cornea and the lens as the rays pass through them. There is considerable concentration near the posterior part of the lens, but the peripheral parts are protected by the great absorptive capacity of the iris, especially if this be deeply pigmented. Moreover there is also reflection from the concave posterior lens surface, so that immediately anterior to the posterior surface an amount of concentration occurs which must be taken into account. By experiment, then, it is found that some ocular structures absorb rays of a certain length to a greater extent than others, and where there is the greatest absorption we find definite pathological changes.

No single formula for a perfect glass, *i. e.* a glass which transmits all the light rays and cuts off all the ultra-violet and all the infra-red rays, has yet been elaborated. No effort has been more successful than that of Sir William Crookes in devising formulæ for different varieties of glass to meet the various conditions. One formula (No. 217), specially designed for workmen employed in glass manufacture, succeeds in cutting

off 96 per cent. of the heat waves and transmits 40 per cent. of light. This glass is a pale blue colour, and consists of—

Fused soda flux . . .	96·8 per cent.
Ferroso-ferric-oxide . .	2·85 „
Carbon	0·85 „

Another and quite different glass, popularly known as Crookes' glass, is designed to deal with ultra-violet rays, and is made in two strengths, A and B. Crookes' A glass has an ultra-violet limit of wave-length 3700 $\mu\mu$ and cuts off 37·1 per cent. of heat, transmitting 99·5 per cent. of light. Crookes' B glass has an ultra-violet limit of wave-length 3600 $\mu\mu$ and cuts off 34·7 per cent. of heat, transmitting 88·4 per cent. of light. It is a darker tint than A.

In conclusion, we find that not only the rays forming the visible spectrum, but also those forming the invisible spectrum, produce, under certain conditions, definite pathological changes in the ocular tissues. These effects require further elucidation in order to prove the exact wave-lengths which cause them.

THE MONOCORD AS A MEANS OF TREATING UNILATERAL HYSTERICAL DEAFNESS

By W. M. MOLLISON, C.B.E., M.Ch., Surgeon in Charge of
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HYSTERICAL deafness can be cured by purely psychical methods, such as explanation, persuasion and re-education, and suggestion under hypnosis or an anæsthetic or by means of a pseudo-operation. Psychical methods can also be reinforced by physical methods, such as stimulation of the labyrinth by syringing the ear with cold water or by rotation in order to produce vertigo. In this paper a new physical method, in which the auditory functions are stimulated by the monocord, is described.

The monocord is an instrument designed to produce high notes. It consists of a steel bar having at each end a small projection; and between these is stretched a steel piano-wire. On the bar moves a "bridge," through which the wire passes; by moving the bridge the effective length of the wire as measured from one end is varied. The wire is thrown into longitudinal vibrations by rubbing it with a piece of wool soaked in methylated spirit or turpentine, or with a piece of chamois leather impregnated with powdered resin.

The instrument can be standardised, since the gauge of the steel wire is the only variable factor; the gauge used is known as 26.

It has been found that by pressing one of the supports of the wire on the mastoid process the notes produced by rubbing the wire are better appreciated through the bone than when the instrument is held in the air near the external auditory meatus. This is true for normally hearing individuals and for a large proportion of the deaf. Normal individuals hear the note produced by about 15 cm. of wire through air and that produced by 14 cm. through bone. In many cases of deafness the much lower note produced by 30 cm. of wire is the highest appreciated through air, while with the instrument pressed on the mastoid a 15 cm. note is heard; it naturally follows that the 30 cm. note will be heard with much greater intensity through the bone.

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This phenomenon has proved most useful in overcoming cases of unilateral hysterical deafness, and has the great advantage of being very simple. No special powers of persuasion are needed. After testing the hearing of the affected ear, the good ear being excluded by means of the noise apparatus, the butt of the monocord is placed on the mastoid and loud notes are produced in the usual way. The patient hears something; he does not quite know what, and perhaps he really hears it with both ears. He is then told he can now hear spoken words, and on testing again he does hear—perhaps at a distance of a foot. A repetition of the monocord notes may be needed and further improvement results, till normal hearing is restored.

The following cases illustrate the effects of the treatment.

Mr. D., aged thirty-five, was sent to me in March, 1920. He complained of right-sided deafness, which had come on during the war. He had had some tinnitus, but that had diminished lately. He had no pain and no otorrhœa. The tympanic membranes, nose, throat and Eustachian tubes were normal. The left ear heard well, whispered words being distinguished at a distance of 10 feet. The right ear heard scarcely anything, loudly spoken words being distinguished only close to the ear. The tuning-fork placed with its butt on the forehead in the middle line was heard by the left ear. The right ear was then almost completely deaf. After sounding some notes with the monocord pressed on the right mastoid process the patient heard spoken words ten feet away from the right ear. In this case liability to deafness had been suggested to the patient by the fact that his father became deaf and dumb at the age of four and was sent to a deaf-mute school.

A second case was that of a soldier sent to the Out-Patient Department with a view to advice about some aid to hearing. He had in his youth undergone a mastoid operation on the left ear and the hearing of that ear was defective. The right ear had now been getting deaf for some months. External examination showed nothing abnormal with the right ear; hearing was very poor: spoken words could only be heard at a distance of three inches, and the 50 cm. notes of the monocord were not heard through the air. However, on pressing the monocord on the mastoid 30 cm. notes were heard. The patient was told he could now hear much better, and after a few minutes whispered words were heard at a distance of eight feet from the ear.

These two cases show that in the monocord we have a simple means of restoring the power of hearing in cases of unilateral hysterical deafness.

LOCAL ANÆSTHESIA FOR THE ENUCLEATION OF THE TONSILS

By T. B. LAYTON, D.S.O., M.S., Surgeon in Charge of Throat and Ear Department, Guy's Hospital.

It would seem that in this country local anæsthetics are seldom used in operations on the tonsils, and in London hardly at all. It may therefore be worth while to record the experience of one who has come to the conclusion that this form of anæsthesia is preferable in the adult to a general anæsthetic in every suitable case. In 1912 I saw Hajek of Vienna remove a tonsil under local anæsthesia. After my return I tried to do the same, but with such want of success that for a long time I did not make another attempt. In the summer of 1919 an American writer described his method of inducing local anæsthesia, and his paper stimulated me to make another attempt. In my first case I removed one tonsil only, and with so much success that I took out the other a fortnight later, and on the same day removed the two tonsils from another patient. Since that time I have used local anæsthesia on every possible occasion.

Hajek used to lay down the rule that one tonsil only should be removed at a time. He urged this because of the fear of hæmorrhage. If the danger of hæmorrhage were so increased with a local anæsthetic as to make it necessary to follow this rule, it would materially impair the advantage of the method. But I am confident that the danger of hæmorrhage is less with a local than it is with a general anæsthetic, and therefore, if there be anything in Hajek's rule, it must apply to all operations on tonsils, or at any rate to all in which the removal is done by dissection. It is probable that no one in this country will go so far as to urge that the routine method of removal of tonsils by dissection should be in two stages with an interval in which the first wound may heal. Experience has shown that Hajek was unnecessarily cautious in his rule, but except in this and in the solution that I use I follow his technique exactly.

The tonsils, their anterior and posterior pillars, and the

dorsum of the tongue are first painted with 5 per cent. solution of cocaine hydrochloride; care is taken thoroughly to paint the groove between the tongue and the lower pole of the tonsil, in order that at the subsequent injection efficient depression of the side of the tongue can be obtained. It was long a nightmare with me that I should fill my syringe from the cocaine solution by mistake. I now have the cocaine solutions coloured red and all solutions used for injection coloured blue. As a further precaution I have my cocaine solution in a glass minim measure, and my solution for injection in a white earthenware cup. When time enough has passed for the cocaine to have taken effect, the injection is made by five punctures for each tonsil,—two into the anterior pillar, two into the posterior, and one into the substance of the tonsil. The upper one into the anterior pillar is made at the level of the lower part of the supra-tonsillar fossa. The point of the needle should be immediately submucous, and the solution is seen slightly to distend the anterior pillar. By pushing the point upwards the area at the junction of the two pillars can be efficiently anæsthetised. When making this puncture it is easy to push the point of the needle through both layers of the anterior pillar into the supra-tonsillar fossa. Warning of this is given by the patient retching and swallowing, and by the sight of the blue fluid coming from the supra-tonsillar fossa. The needle must then be removed and re-inserted. The lower puncture into the anterior pillar is made into that fold which carries the palato-glossus muscle to the side of the tongue. From it the solution is made to pass up until it meets that which was injected through the upper puncture. The point of the needle is then pushed downwards and backwards into the groove between tongue and fauces, where the lower pole of the tonsil lies. The upper of the two punctures into the posterior pillar of the fauces lies on the level of a point which is midway between the two punctures into the anterior pillar. The lower puncture into the posterior pillar is made as far down as is possible by firm depression of the side of the tongue while the patient takes a deep breath. Lastly, a puncture is made into the substance of the tonsil low down; here, again, it is likely that the point will pass through into a crypt and the solution escape from its orifice.

I have used some half-a-dozen different kinds of syringes and needles, including Gray's syringe and one used by dental surgeons for anæsthesia of the gum. None is so convenient as the needle used by Hajek, a copy of which I brought back with me from Vienna. Its length prevents any necessity of

getting part of the syringe into the mouth, the curve at the end is such that with a small tilt upwards the point is easily pushed into the submucous tissue; the shoulder at the end of the straight part prevents the point of the needle going in too far, and this does away with all fear that some sudden movement by the patient might injure a vessel or other structure.

Hajek used Schleich's solution. Except in the unsuccessful attempt mentioned above I have not used it, but have used novocaine. I have used solutions of $\frac{1}{2}$ per cent., 1 per cent. and 2 per cent. On the first occasion that I used the last, there resulted such a blanching of the tissues that I feared a reaction of hæmorrhage when the effect passed off. Nothing untoward happened however, and I now use this strength as a routine. My reason is that I may obtain the anæsthetic effect with the use of as small a volume of fluid as possible; for where much is used, the œdema interferes mechanically with the operation. In a successful case where none is wasted, about three drachms are used for the two sides; with more experience I feel confident that two drachms or less should suffice. To my novocaine solution I add adrenalin hydrochloride in the proportion of one drop of the 1 in 1000 solution to a drachm of novocaine solution (1 in 60,000). Hajek used to say that for fear of hæmorrhage adrenalin should never be injected for this operation, but American surgeons use it fearlessly. Dr. P. P. Laidlaw told me he thought that we were in the habit of using our adrenalin solutions too strong, and that I should get as good a result with solutions of 1 in 60,000 or less as with those of 1 in 15,000 or 1 in 30,000 which I had been using. As a result of this conversation I tried the above solution, and I find it thoroughly satisfactory.

The operation may be done with the guillotine or by dissection. Though the anæsthetic removes all pain and the sensation from the mucous membrane, it does not prevent an unpleasant feeling when the tonsil and tissues are dragged upon. Pulling on the tonsils or pharyngeal wall also causes reflex swallowing and retching. For these reasons I perform the whole operation by scissors and forceps, treating the area with the utmost gentleness and not resorting to blunt dissection unless driven to do so. A pair of toothed tonsil forceps, a long pair of toothed dissecting forceps, and a long pair of blunt-pointed scissors curved on the flat are used. The tonsil is pulled from its bed and the mucous membrane cut through as near to it as possible. Often the tonsil is so friable or so fixed that it cannot be dragged forth, or the patient's reflexes are so brisk that he will not admit of this; then the anterior

pillar must be cut through and the capsule discovered beneath. In either case the incision is carried down to the side of the tongue and over the upper pole of the tonsil and as far down its posterior margin as possible. The upper pole of the tonsil is then found, dislodged, and gripped with the tonsil forceps. This pole is then pulled downwards and inwards and the strands of cellular tissue separating the capsule from the pharyngeal wall are thus put on the stretch. They are cut through with short sharp snips, so that the points of the scissors are kept touching the capsule, and thus the whole is separated from its lateral relations. The tonsil is then pulled upwards, inwards and forwards, and the lower blade of the scissors placed below it while the upper is between it and the pharyngeal wall; the points of the scissors are seen protruding behind, and the mucous membrane beneath the pole is cut through. In this way the points of the scissors are seen during the whole operation. This last cut is the least easy thing to do, and owing to the dragging that is necessary is the most unpleasant part for the patient, but it is soon over. The lower pole is then examined to see that the whole is removed. If the lymphoid tissue is seen to be cut through, a small piece will be found in the tonsil bed below and behind and can readily be dissected out. I begin with the patient's left tonsil. When doing the right, it is sometimes easier to cut through the posterior pillar first, and thence to go to the upper pole or even to turn the tonsil forwards and to take it from its bed that way instead of from above downwards. It matters not which way it is done, so long as one does not hesitate. The duration of the operation itself is only a few minutes up to ten. Including the anæsthesia I have left the ward in thirty-five minutes from the time I entered it when operating upon a private patient.

A few notes upon light and position may be of value. The operation can be done with the aid of the head lamp, with the frontal mirror, or with the light coming over the operator's right shoulder from a window or artificial light. This variation enables the operation to be done anywhere. I have done it in my consulting room, in a lady's bedroom, and in the sitting-room of a working-man's cottage, but I prefer to do it in an operating theatre. When using the guillotine I have the patient lying down, but for the usual operation with scissors and forceps sitting up. The patient should sit with the head slightly bent forward; this causes saliva to flow to the front of the mouth and saves swallowing movements. This position is quite convenient if the surgeon sits on a lower chair than the patient so that he is looking up into the mouth. With a

difficult patient I have had the head leaning back on a rest and have stood over him, leaning forward myself; but I do not recommend this position, as it necessitates frequent halts for the patient to spit. The less often this is necessary the better, and the surgeon must not allow the patient to expectorate too frequently at each halt, and must insist upon the mouth again being instantly opened so as to get on with the work without delay. If excessive expectoration be allowed or encouraged, the patient develops the habit of it and wants to do so more and more, while much time is taken up and the patient's courage evaporates.

This brings one to the selection of the patient. The operation demands some determination upon the part of both surgeon and patient. If the former has the slightest want of confidence in his power to do the operation, he may unconsciously let the patient realise this and make his task the harder. So also the presence of any one in the theatre out of sympathy with or sceptical of the method will react upon the patient and make it more difficult both for him and for the surgeon. It is a function of the surgeon when he examines the patient and advises operation to decide whether he or she has enough determination to go through the ordeal. I am certain that the discomfort of the operation and convalescence is far less when it is done under a local anæsthetic than under a general one. The difference is that in the one case the discomfort occurs during the operation, when the patient, being conscious, can at the last moment fail in courage, and that in the other case it occurs after all is done, when the patient is left in bed, not to be seen again by the operator till the worst is over. The patient must assist the surgeon, and if he has not enough personality to do so, it is well not to use the method. In my opinion the operation should never be performed under local anæsthesia against the will of the patient, nor even when the patient needs much persuasion to consent to it. I do not advocate the use of a local anæsthetic in children, for the same reason as I do not now use the method of removing tonsils without any anæsthetic. The operation can easily be done, and the child will allow the surgeon to examine the mouth within a half-hour of the operation, but it seems to leave a permanent sense of fear in the child's mind, which is bad for its development, and which makes a future visit to the doctor so terrible an ordeal that he cannot make an efficient examination or correctly estimate the importance of the child's symptoms. But it is not only patients devoid of personality or courage who are unsuitable for this method. There are

others, whose reflexes are so brisk that they will not allow a depression of the tongue or the slightest manipulation of the throat without swallowing or coughing.

Before and during the operation everything must be done to keep up the patient's determination. It is well to allow him to carry on his usual occupation during the day until a short time before the operation, and to arrive at the nursing home or hospital only about half-an-hour before the operation is timed to take place. It is well to inject the local anæsthetic in the bedroom. The patient has not then to begin to screw up courage until the operation actually begins, and he does not spend the time in which the anæsthetic is taking effect in looking at the unusual sights of the theatre and the preparations for operation. During the operation there must be no hesitation, no undue pulling, and no unnecessary manipulations. The patient's mind must be kept off the matter in hand, and for this it is by no means a disadvantage for the surgeon to develop a continuous flow of inconsequential chatter. Nothing must be done to suggest failure, and for this reason to demonstrate the operation to an onlooker always makes it the more difficult to perform. The demonstrator must indicate where difficulties are to be met, and this begins to shake the patient's confidence.

Men and women vary very little in their suitability for local anæsthesia. Perhaps more men than women are found suitable for it, but when they are suitable, women are even better patients. If anything private patients are rather better subjects for local anæsthesia than hospital patients.

In conclusion, I would add a few words about hæmorrhage. The slight amount of hæmorrhage with local anæsthesia is the most important point in its favour; perhaps the local infiltration helps, the position of the patient may be of some assistance, but I feel confident that the precision with which the operation can be done is the most important factor. It would seem almost that tonsillar tissue does not bleed in the cellular bed in which it lies. It is when one goes deeper and damages the muscles underlying that there is danger of bleeding. Under local anæsthesia every snip of the scissors is seen and the muscles are never damaged, so that the chances of bleeding are reduced to a minimum.

ADDENDUM.

THE following are extracts from letters from patients who were asked to describe their sensations when undergoing the operation.

(1) Mr. W. N. D., schoolmaster, *æt.* 50, operation in Bright Ward in January, 1921 :

“ In the first part of the application, there was no discomfort whatever beyond the usual tickling of the throat as when a brush is applied, causing after a time an inclination to retch, and also the discomfort of the strain in holding the mouth open for a time. Between this and the second part of the application I felt quite normal; in the second part of the application just a slight prick was perceptible. Whilst resting after this, there was for a few minutes a peculiar sensation (only slight) as if one might become giddy, but without any real giddiness. In five or six minutes I was able to walk all right through the ward.

“ In the operation itself the chief ordeal was to hold the mouth open for so long, and keep steady under unusual circumstances; *i. e.* with instruments in the mouth and throat. But this is after all not so difficult with a little determination. I fancied I could feel that something was being cut without feeling any pain; once a slight sensation of a cut was felt; one can really say it is a perfectly painless operation.”

(2) Miss M. A. T., *æt.* 24, operation in a nursing-home in September, 1920 :

“ Whilst you were painting and pricking the tonsils I never felt any unpleasant feeling, save, at the end, a slight dizziness came over me which soon passed by.

“ The operation itself was quite painless. At first I thought I should feel a slight pain when the cutting commenced, but to my surprise I felt no pain whatever, although I distinctly heard the clipping of the instrument. After the operation I felt no ill effects and was soon able to resume my duties.”

(3) Mrs. T., *æt.* 35, operation in Bright Ward in October, 1920 :

“ Of the actual operation there was no pain whatever, but a peculiar sensation of the clicking of the scissors. The only disagreeable feeling of the local anæsthetic was that I had no control over my throat and tongue for the time being.”

(4) Miss M. C., an actress, *æt.* 16, operation on left tonsil only in my consulting-room in November, 1919 :

“ To be perfectly candid with you, I do not like the local anæsthetic, and if I had to have another operation I should certainly have chloroform or ether.”

(5) Mr. A. J. R., *æt.* 32, a carpenter, operation in the sitting-room of his own cottage in November, 1920 :

“ With the local anæsthetic there was practically no pain while it was being done. I have never had chloroform, but if it was necessary for it to be done again I should much prefer the local anæsthetic.”

MASTOIDITIS AND COMPLICATIONS WITHOUT PREVIOUS OTORRHOEA, AND SOME OBSERVATIONS UPON THE RESOLUTION OF MASTOID INFECTIONS

By A. M. ZAMORA, M.Ch. (From the Throat and Ear Department,
Guy's Hospital.)

THE question of diagnosis and prompt treatment of early and atypical cases of mastoid inflammation has attracted the attention of this Department, and has been the subject of various communications.^{1,2} The following cases are collected further to point the moral and adorn the tale.

Case 1. V. M. A., 25, married. When first seen five weeks after confinement, she complained of pain on the left side of the neck dating from the day of birth of her child. The pain extended up to and behind the left ear, and she complained of slight deafness on the left side. She stated that she was often troubled with hoarseness, sore throat and catarrh. Objective signs were slight swelling over the mastoid region and slight stiffness of the neck. *The tympanic membrane was normal and the meatus quite dry.* The postero-superior meatal wall showed a mild flushing but no swelling, and after discussion this sign was considered to be insufficient to be of any significance, in view of the facts that the hearing was only very slightly impaired and that there were no evidences of tympanic inflammation. The nose showed some atrophic changes, accounting for the catarrh and hoarseness.

The condition remained more or less stationary till seven days later, when the temperature was 100.5°, the pulse 100, and the notes state "left mastoid somewhat swollen and tender on pressure and percussion—skin red." The tympanic condition remained unaltered.

At operation on the following day it was found that a large cellular mastoid process was completely disintegrated and full of pus, which had perforated the cortex at no fewer than four distinct places—one about 1 inch behind the meatus in the angle between the lateral sinus and middle fossa, another immediately below the antrum, a third into the groove of the lateral sinus, forming a large peri-sinuous abscess, and a fourth through the mesial aspect of the mastoid process into the

digastric fossa, forming a Bezoldt's abscess, occupying the deep aspect of the sterno-mastoid sheath. The necrotic process had extended to the neighbourhood of the stylo-mastoid foramen. After the operation facial paralysis was observed, which has now cleared up and was probably due to neuritis caused by infection and operative interference at the stylo-mastoid region. A large collection of pus had to be evacuated from the neck at a subsequent operation by incision along the anterior border of the sterno-mastoid.

Apart from the absence of otorrhœa in this case there are certain other points of interest. Bezoldt's abscesses are distinctly rare. In a series of sixty-four unselected cases reported in the Mayo Papers there was one case of Bezoldt's abscess, and this probably represents too high a percentage. The complete lack of resistance of the patient due to her debility after confinement allowed the disease to travel unopposed, and the points of perforation illustrate well the paths of spread emphasised in previous notes.² The facial paralysis is a sequel, which is to be looked for in these cases of Bezoldt's abscess, owing to the invasion of the stylomastoid region by disease.

Case 2. Miss H., 20, gave a history of doubtful influenza three or four weeks previously, with pharyngitis and nasopharyngitis, earache, and deafness in left ear for fourteen days or more, and high temperature ten days or more; no rigors, *no otorrhœa*, but great pain at intervals. On examination the left membrane was dull and irregular and the patient could hear a whisper at 2 inches only. There was tenderness over the mastoid and slightly in the neck.

At operation there was pus in one spot over the lateral sinus above and behind, granulations leading from antrum to sinus, peri-sinus granulations, and parietal thrombosis.

The sinus was opened and the jugular vein tied. On the following day it was necessary to operate again, for the thrombosis had extended $1\frac{1}{2}$ inches further back. The patient recovered.

Case 3. Mr. W. A. W., 20, seen on December 30, 1920, gave a history of inflammation in the left middle ear six months previously with *no otorrhœa*, but pain on and off ever since—at times very severe. The present attack of pain dates from five or six days previously, and the pain is frontal and in the left ear, but has been all over the head. He wakes repeatedly in pain, and complains of loss of appetite. There is no discharge or stuffiness in nose.

On examination, the left membrane is pale, bulging and thick looking, the right membrane normal. A whisper could be heard at 6 inches on the left side, and the passage of a Eustachian catheter gave the impression of fluid in the left tympanum. Tenderness is present over the mastoid triangle and tip, especially on pressing backwards.

31. 12. 20. Incision of membrane.

3. 1. 21. Temperature normal; still pain; tenderness very slight; little thickening over mastoid; ? left eyelid very slightly puffy. Roof of meatus swollen deeply; membrane still bulgy.

4. 1. 21. Operation: bone everywhere contained points of sepsis; pus about half-way down mastoid; granulations in the aditus; very thick extradural abscess over posterior fossa.

Had severe attack of vertigo for two days following operation, but recovered suddenly and spontaneously.

Case 4. Mr. Y., 17.

Feb. 10. Earache.

" 12. Temperature started rising.

" 14. Temperature 104° .

" 15. Operation in the country (E. W. S.). Pus in mastoid. Lateral sinus exposed over small area.

" 16. Temperature 102° .

" 17. Temperature 102° .

" 18. Temperature 103° . Seen by W. M. M. The patient looked ill; tongue very dirty; had felt cold, but had had no definite rigors. The wound was septic, and the lateral sinus felt flabby to the probe. Operation: local thrombosis of sinus; jugular tied.

" 20, 21 and 22. Temperature normal.

Recovery.

There was never any otorrhoea in this case.

Case 1 was treated by me in Mr. W. M. Mollison's Clinic, and the rest are from his private practice.

Authorities are all agreed as to the extreme rarity of mastoiditis as a strictly primary condition. It is questionable indeed whether in the strictest sense of the term acute primary inflammation of the lining membrane of the mastoid cells occurs, except in such rare instances as to be outside the limits of practical consideration.

There are, however, cases in which mastoiditis appears after the complete subsidence of middle-ear suppuration, and others in which the mastoiditis is so pronounced that it overshadows the middle-ear symptoms to such an extent as to justify its consideration as an independent condition. Yet another series of cases is associated with localised epi-tympanic suppuration, the effect of which upon the membrane is such that it can only be recognised by an expert after most careful examination.³

The important point seems to be to realise that the suppurative process once established in the mastoid may proceed quite

independently of the tympanic condition, and for this reason the middle ear cannot be looked upon as a certain guide to the mastoid condition.

Investigation of cases from the point of view of early diagnosis suggests that this type of case is far more common than is at present believed, only the later stages bringing them within the more generally accepted grouping.

Cases of this type recorded in literature are rare, and for this reason it was thought that the present series was worthy of report. Yet the cases reported from the Guy's Clinic are to be looked upon as typical of a definite group of great importance, and the inference is that they are not generally recognised. Ballance⁴ reports the case of a male, aged two, operated on for double hare lip, who, after gradual emaciation without fever beyond an occasional rise to 99°, died a month after operation, and in whom sepsis was suspected but not localised. At autopsy there was pus in the right tympanum which was carious. *The tympanic membrane was normal.* There was a puriform clot in the right lateral sinus and small hæmorrhages in pia, pleuræ and lungs. Knapp⁵ reports the case of a child aged five with "both auricles, ear canals, *tympanic membranes and middle ears normal*, as far as physical examination could discover;" yet for many months the "mastoid and supra-auricular region of the temporal bone were swollen, ulcerous, granulating and discharging fetid matter," and at operation extensive necrosis of the mastoid bone was found.

Mollison¹ reports a similar case.

Politzer⁶ holds that in every case of acute suppurative otitis media there is a period, during which there is pus present in the mastoid antrum and cells. The converse would probably also hold, and it is to be assumed that only when there happens to be efficient occlusion of the aditus by swollen mucosa can mastoid suppuration progress independently of tympanic infection. The occlusion of the aditus accounts for the spread of the disease in a dangerous direction. It is to be noted that all the cases reported showed untoward complications.

The fact that the petro-mastoid bone represents the capsule laid down around the modified branchial cleft as well as the support supplied for the otic capsule gives it special paradoxical characters in relation to suppuration. It is at once more exposed and more immune than other bones, for the extension of the nasopharyngeal mucosa is both a source of infection and a mechanism of protection. Again, drainage can take place readily, for there are easy channels of escape viâ the aditus and tympanum to the external meatus and Eustachian tube; but

if resolution is incomplete or delayed, there is serious danger that intracranial complications may arise.

There are many borderland cases, in which the mind of the surgeon is much exercised as to whether to open the mastoid or not. Some of these declare themselves by passing through the stages of vascular engorgement and cell infiltration to that of suppuration or even osseous necrosis; these cases are operated on and are in a sense more fortunate than a second large group, in which resolution takes place and with it a passage of serous or purulent discharges through the middle ear to the exterior.

It is suggested that what is apparently a happy result in this last group is in reality a dangerous ending, for, though suppuration may completely subside, yet there has been during the attack a collection of irritating material in the hypo-tympanic space, which forms the starting-point of a series of hypertrophic, sclerotic and finally atrophic changes in the tympanic mucosa, resulting in loss of absorptive power of the tympanic lining and interference with ventilation of the space, by bringing about a stenosis of the tympanic end of the Eustachian tube. Henceforward the patient is unable to deal with the recurrent infections to which he is liable, and the foundation is laid for a chronic adhesive middle-ear catarrh, which, once established, is highly intractable. Nor is this the only sequel to such a resolution of mastoid inflammation left to nature. Fraser⁷ believes otosclerosis to be the sequel of middle-ear inflammation, especially of this type.

Finally there is a large series of cases, in which the condition settles down to a chronic infective process of low degree throughout the whole antro-tympanic and mastoid system, with gradual loss of function and no brighter prospect than the dismal necessity of a radical mastoid operation to save the patient from imminent danger of death by intracranial extension.

Resolution certainly takes place in many cases, and it is in the hope of obtaining this result without operative interference that such inadequate measures as Wilde's incision, Leiter's coil and similar procedures are adopted.

The importance of the cases recorded lies in the fact that by actual observation it was established that the grossest changes may occur without the usual visible external signs. How much less probability therefore is there of gauging correctly the extent of those minor tympanic changes which have such dire remote effects.

The findings emphasise the importance of examining in every case the clinical picture as a whole on the lines laid down by Mollison,¹ in the hope of being able to interfere by operation

at the earliest possible moment, having especially in view the possible late effects upon the tympanum.

Politzer ⁶ holds that it is advantageous to wait for localisation and abscess formation, but the experience of this Department points very definitely to the advisability of operating at the earliest possible moment. No case can be more valuable in the illustration of this principle than that of L. D., whose operation was delayed in the hope of resolution, and who developed an acute nephritis as a direct result, but recovered completely after a Schwartze operation.

On the basis of the experience in the Guy's Clinic, it is suggested that the pre-suppurative congestive stage is the correct time to operate. The exenteration of the mastoid process can be accomplished rapidly and with a remarkably small operative risk, and—with the introduction of modern methods of bone disinfection such as bismuth iodoform paste—the duration of convalescence is shortened and the results from every point of view improved in an inverse proportion to the duration of disease at the time of operation.

To wait for definite abscess formation or to vacillate in the hope of resolution are both unjustifiable attitudes, except perhaps in the case of very old patients, in whom the preservation of function is not of such vital importance and in whom the anæsthetic risk becomes considerable.

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STUDIES ON TUMOUR FORMATION

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INTRODUCTION

TUMOUR formation must ultimately depend on one of two causes. The cell or cells from which the neoplasm arises must either be abnormal *ab initio*, or else some external stimulus must induce a normal cell or group of cells to proliferate abnormally. In default of certain knowledge both these views have been held and have given rise to a multitude of theories. To assume that the cell has always been abnormal is a very comfortable view to take, since every phenomenon of neoplasia is readily explained by its aid. But, in the present state of our knowledge, it is nothing more than one of the innumerable ways of begging the question. The thing to be explained forms a part of the explanation. Besides, it shuts the door most effectually on every attempt at investigation. We know nothing about the fate of abnormal cells. Multi-nucleated ova have been frequently described, and I have myself seen them in apparently healthy adult ovaries. A large number of abnormalities of the spermatozoa are known. But can these cells conjugate, and, if they can, what will be the result? Even in the lower animals, in whom it is possible to induce polyspermy, the embryo perishes in the blastula stage. Such experiments do not help us at all in our attempts at finding an explanation of tumour formation, a process occurring in an otherwise normally developed individual. I am filled with amazement at the fact, which surely is the most wonderful thing in a very wonderful world, that the huge majority of children that are born are normally developed and that they are not formless lumps of flesh, and that gross abnormalities, as we call them, deserve their name and are not the rule. Ought we not to try to show why things so very generally go right, rather than why they occasionally go wrong? Surely this suggests that the cell from which the embryo develops is practically always a healthy one, and that it will grow into a healthy individual if it gets the chance, *i. e.* unless its development is interfered with by some abnormal stimulus. What applies to the whole, applies to its parts—

when there is an abnormality, it has a cause external to itself—and as tumour formation is essentially an abnormality of growth, it applies to it as well. I shall therefore say no more of the theories that postulate a *vitium primæ formationis*.

Nor do I intend, for the present, to say much about the other theories, those that have been woven around the second possibility, that tumour formation is due to a stimulus external to the cell. They are all good in their way and contain a grain of the truth. When pressed home, however, they all fail. The reason is not far to seek. We shall find it if we attempt a definition of neoplasia. Let us go to the text-books for this purpose. Thus, Adami,¹ after pointing out that “too often have theories as to the causation . . . entered into the definitions,” adopts C. P. White’s statement that a “tumour proper is a mass of cells, tissues or organs resembling those normally present, but arranged atypically. It grows at the expense of the organism without at the same time subserving any useful function.” Ewing² defines a tumour as “an autonomous new-growth of tissue.” MacCallum³ is more cautious. He says that it is only possible to attempt a definition of tumours after a survey of their characters, and proceeds: “In the meanwhile it may be said that they are masses of tissue resembling, but not perfectly identical with, the normal tissues, which grow without any regard for the laws which govern and restrain the growth of normal tissues. They are supplied with blood-vessels and a sufficient supporting framework by the host, and derive their nourishment from the circulation of the host. Therefore, like any parasite, they are harmful to the person in whose body they grow; but the injury which they do becomes intolerable when they not only absorb this essential nourishment, but also invade and destroy the normal tissues.”

As one of the principal objects of these studies is an attempt to show that these and similar statements are not true definitions, since they do not define, I will for the moment rest content with pointing out that Adami’s adopted definition most certainly includes all malformations, not excepting hemi-acardiac parasitic monsters. If Ewing’s definition holds good, then the fœtus in utero is a tumour. We shall see, as we proceed, how near MacCallum comes to a definition. The reason why these definitions break down lies in the nature of tumours. In no essential character do they differ from the other tissues of the body.

In conclusion, I shall attempt to develop my subject by the aid of the material that I have personally examined, and employ my knowledge of the literature merely as an aid and as a check

on hasty conclusions. Many important instances pro and con will therefore be necessarily omitted, for my material, although far from small, is still smaller than I could wish. The alternative would have been to have entered into a full discussion of the literature. But this is almost overwhelming. The first course is, I believe, the better of the two. It is certainly the more agreeable and much the shorter.

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I. THE MORPHOLOGY OF TUMOURS

Tumours, as we have seen above, are spoken of as masses of cells, resembling those normally present, but arranged atypically. They are autonomous, and grow without regard for the laws which govern the growth of normal tissues. They are supplied with blood-vessels from the host, and since they derive their nourishment from his circulation and therefore grow at his expense, they, like parasites, are harmful to him. At the same time they subserve no useful purpose.*

It is but fair to state that these sentences are interdependent and that they must not be analysed separately. The penultimate, for instance, can be made to apply (saving the deduction) to the liver or any other organ quite as readily as to a tumour. But I venture to doubt their accuracy even when taken together. Many tumours are very typical in structure, and a great many quite as much so as many malformations. They are certainly autonomous, but so are all the organs of the body. That they grow without regard for the laws that govern the growth of normal tissues I flatly and most emphatically deny. Function is intimately connected with structure, and we shall see that many of the more typical tumours are by no means without function. My present object is to compare the structure of tumours with that of other tissues and organs of the body, and to show that, far from being atypical in every case, some of them surprise us by the degree of typical differentiation they attain.

* The second part of MacCallum's last sentence (*vide* Introduction), does not apply to all tumours and therefore need not concern us here.

The reason is obvious why such opinions as those enumerated above are held. Tumours are usually harmful. The majority of the investigations carried out on them have as their aim the discovery of the readiest means of getting rid of them and of prolonging the lives of the individuals afflicted with them. The view that is taken of them is therefore biased. This is a mistake, as it is only by adopting the point of view of the tumour, or at least an absolutely impartial view, that we can hope to understand its structure and functions completely. Not until after a full understanding will have been obtained, can we hope successfully to tackle the problem of how to abolish tumours.

If a large number of tumours be examined, the fact is quickly revealed that they are built up on the same plan as the tissues in which we assume that they arise. Not only do the individual

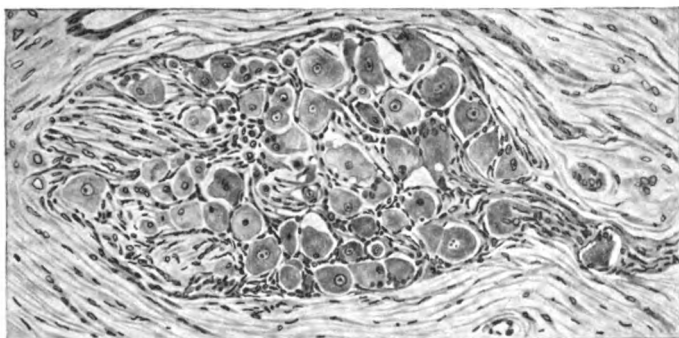


FIG. 1.

Ganglion from retro-peritoneal teratoma of a child of three months. Magnif., 180.

cells often closely resemble the corresponding normal ones, but their mode of growth and the manner in which they are grouped to form tissues and organs is sometimes remarkable. This is obvious in most innocent slowly growing tumours, and is often apparent in malignant ones as well.

Fig. 1 has been drawn from a large retro-peritoneal teratoma of a child of three months. It represents a well-formed, though not fully-developed and matured ganglion. Differentiation has advanced farthest on the right side of the drawing. Here there are very perfect ganglion cells, some of which contain a brownish pigment (which I have not attempted to reproduce). They are surrounded by definite sheaths, and nerve fibres issue from several of them. These run to the right, where they are collected into a nerve bundle, near the beginning of which there is an isolated ganglion cell. Towards the left of the figure the ganglion cells become smaller and differentiation is still taking

place.* I am not sufficiently familiar with the appearance of the developing nervous system to assign to this structure the exact period of embryonic life to which it corresponds most closely, but I feel sure that it is one of the later weeks. We must remember that the child died very young and that its teratoma had lagged slightly behind in its development; not very much, however, as will appear in a future paper, in which I hope to describe this interesting specimen at some length. I am justified in claiming that it is more than a mass of ganglion cells in a teratoma. It is a ganglion corresponding in its development to one of the later weeks of embryonic life.

Since I am dealing with teratomata, I may mention that they contain a surprising number of tissues. I believe I am right in saying that all the principal organs of the body have been described in them, with the exception of the reproductive cells (Ohkubo ⁶). Even such specialised organs as Pacinian corpuscles have been recorded on more than one occasion (Nakayama ⁷). I myself have seen a plexus of Auerbach on the intestine of an ovarian "dermoid"; also a thyroid and thyroglossal duct. I shall say no more about teratomata here, only this: they, more than other tumours, emphasise the fact that the majority of neoplasms, if not all, have an organoid (Albrecht ²) structure, and refute the statement that they grow without regard for the laws which govern the growth of normal tissues. It is only by regarding tumours as aborted organs that we can hope to understand their structure and their growth and development. It may even be that by their aid a clearer insight will be gained into some of the problems of normal development and growth.

I have just said "aborted organs." That a tumour sometimes copies a perfect functioning organ very closely indeed in its structure, is shown by my next specimen. It is of sufficient interest to deserve a short description. The patient, a married woman of twenty-seven, mother of several children, was admitted under Sir Alfred Fripp (who has kindly allowed me to use the case), for a rounded, firm, freely movable, non-adherent swelling of the left breast, which she had first noticed some eight months before, during her last pregnancy. Since then it had steadily increased in size. The baby, at the time of her admission to the hospital, was four weeks old; it has not been breast-fed. There has been no discharge from the nipple. The tumour was easily enucleated, since it was surrounded everywhere by areolar tissue and attached to the substance of the breast by its vessels

* A comparison of Fig. 1 with Fig. 378 of Schaefer's *Text-Book of Microscopic Anatomy* (1912) shows that the differences between them are not great.

at one spot only. The specimen measures 8 by $7\frac{1}{4}$ by $4\frac{1}{2}$ cm. in its largest diameters. It is roughly egg-shaped in outline, but is considerably flattened in one dimension. Its surface is smooth, except for a few slight irregular prominences. It is surrounded by an envelope of loose areolar tissue, in which a few small lobules of fat are enclosed, together with an artery which, after running for some distance in a shallow groove on its surface, disappears by entering its substance. It is firm and elastic in consistency. Its colour is mottled, white and pink, with numerous small bright yellow and orange areas, surrounded by bands of hæmorrhage. These become confluent to form large, very irregular patches, which are slightly raised above the surface and are most numerous on one side of the specimen. They are due to necroses, and do not concern us here. On being cut open, the tumour is found to consist of an outer fibrous layer, which forms a distinct capsule of more or less concentric laminæ. It varies greatly in thickness, and sends several prolongations into the substance of the tumour, one of which is much broader than the others. The prolongations form a meshwork of fibrous septa, and enclose rounded and oval masses of a softer greyish tissue, which are imperfectly divided by fibrous bands, and appear to be built up of numbers of small rounded nodules. (Some of these masses are yellow and necrotic and surrounded by hæmorrhage.) A few small cysts are enclosed in the substance of the largest fibrous septum. They average 5 mm. in diameter.

Fig. 2 illustrates the structure of this specimen. It was drawn from somewhere near its centre. It shows parts of several mammary lobules in an early stage of lactation. They are large, but the biggest of them, fully three-quarters of which is represented, is much smaller than a good many of those of a lactating breast I have compared it with. Owing to their secretory activity, the majority of the tubules are dilated and their epithelium flattened, but a good many small resting tubules are scattered about. Several small intra-acinar ducts can be seen. The stroma of the lobules corresponds to that of a normal breast, and so do their contours and the fibrous tissue that surrounds them, in which there is a duct filled with secretion. All the sections examined, except where necrosis had occurred, showed precisely the same structure, except that in some of the lobules there were more resting tubules, whereas in others there was greater activity. A duct was seen to enter the periphery of a lobule. The broad septum described above showed the usual appearances of a chronic mastitis, with atrophy of the lobules and moderate proliferation and dilatation of the ducts.

I could find no evidence of a duct in the areolar tissue around the tumour. There were present a few atrophied mammary lobules, which still retained evidences of secretion.

We have here a tumour which is independent of the breast, but which imitates the histological structure of that organ in the most complete fashion, and shows not the slightest signs of excessive or atypical, or, in other words, blastomatous growth. Secretion, as far as can be judged, had been going on in a physiological manner. The presence of resting tubules among the active ones is perhaps the most interesting of all its features,

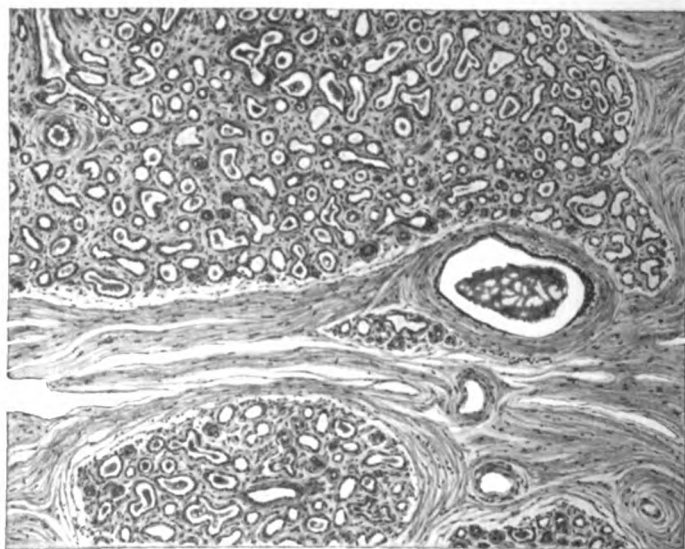


FIG. 2.
Lactating adenoma of breast. Magnif., 80.

since it suggests a very delicate functional adjustment and balance of our tumour.

To name it a fibro-adenoma with an albuminous and fatty secretion conveys no meaning. We can only appreciate the structure of this specimen when we look upon it as a lactating breast. The question therefore arises: Is such a perfect organ as this appears to be a tumour, or is it an accessory lobe, that has somehow become isolated from the rest of the mammary gland, although remaining imbedded in its substance? The presence or absence of a main duct appears at first sight to be helpful to our answer to it. But this is not really so, as accessory organs, as we call them, have not invariably got a duct (I need but instance accessory lungs, which are often without a bronchus),

whereas many undoubted neoplasms open on the surface of mucous membranes and ducts just like normal glands.

I do not mind confessing the truth at once : I cannot answer the question one way or the other. On looking at this shapeless lump with the naked eye, it would be simple affectation not to call it a tumour. It is only the knowledge of its minute anatomy that raises doubts.

This brings me to the sum and substance of this paper. There are no essential differences, or indeed any differences at all, between tumours and accessory organs, *i. e.* malformations. As Schwalbe¹² has pointed out, and others before him, there is an unbroken chain, forged of exceedingly fine links, between

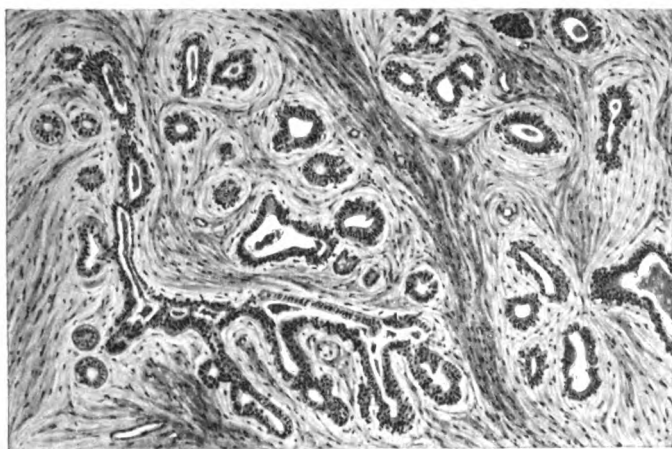


FIG. 3.
Fibro-adenoma of breast. Magnif., 90.

uni-ovular twins on the one hand, and the simplest tumours on the other. They are all malformations. This is proved by the delicate adaptation of the tissues to each other in many tumours. Of this the present one is an exceedingly good though very unusual instance. But what does it matter how uncommon it is? In the study of tumours, more perhaps than in any other branch of science, it is the exception that proves the rule. I have learned more from one rare and complicated tumour than from dozens of common and simple ones. I feel sure that all pathologists will agree with this statement.

But let us see what we can learn from common tumours, and look at a fibro-adenoma of the breast. I have picked the specimen from which the above figure has been drawn out of several dozens in my collection, not because it shows any

point of particular interest, but merely because it is typical of this kind of neoplasm. In Fig. 3 there are represented several irregular epithelial tubules, the largest of which is extensively branched. Their cells have proliferated to a degree which is in excess of the normal. This is shown by the somewhat irregular heaping of the nuclei, three or four layers being present in many places, as well as by their variation in size and shape. The stroma has proliferated to an even greater extent. Around most of the tubules it is delicate and open, but soon becomes more dense and fibrous. A very definite septum of condensed fibrous tissue passes diagonally across the drawing.

We here have a structure which can at once be recognised as a fibro-adenoma, and which at first sight bears no resemblance to the normal breast. But, on looking at it more closely, it becomes evident that it is built up on the same architectural plan as that organ. The shape of the individual cells does not show anything characteristic. Even under high magnifications it would be difficult to state for certain that they came from the breast, or, for that matter, from any other organ. But the shape of the tubules, although distorted, has a resemblance to that of mammary acini. Thus the long irregular tubule, whose two limbs meet at a right angle, and whose lumen is filled with secretion, is a caricature of an intra-lobular mammary duct. Its branches correspond to the secreting acini of the gland. Their epithelium shows a distinct tendency in several places to be grouped into two layers, each of them one or more cells in thickness,—another resemblance to the mammary glands. The dense oblique septum indicates a division into definite lobules. Within these we have a more fibrous general stroma, and a much looser and more delicate sheath surrounding individual tubules, an attempt at reproducing the characteristic structure of the stroma of the breast. I must add that all the lobules are distinct from each other as far as the epithelium is concerned; none of the tubules pass from one to the other across the intervening septa. Proliferation of cells, of the epithelium as well as of the stroma, is in excess of what occurs in a normal organ, but not of what we see in inflammatory reactions. It can most definitely not be called blastomatous.

I claim, therefore, that this specimen which, as I have said, is a typical fibro-adenoma of the breast, shows very distinct and evident, although distorted, imitation of the structure of the normal gland; that it has obeyed the laws which govern the development of the normal organ; and that it has copied the outlines of its structure. It differs from the mammary gland in the greater amount of growth that its tissues have undergone,

and in the abnormal proportion and faulty blending of the several tissues with each other. These differences are quantitative and qualitative, but not fundamental. The nature of the tumour is more truly expressed by calling it a malformed breast than a fibro-adenoma. I am in complete agreement with Albrecht¹ when he looks upon mammary fibro-adenomata as aborted organs, *i. e.* malformations, and when he uses them as a strong argument in support of the view that there is really no borderland between malformations and tumours. I again emphasise that the epithelium and the stroma have undergone excessive and irregular growth, and that the specimen is most certainly a tumour, in the generally accepted sense of the word.

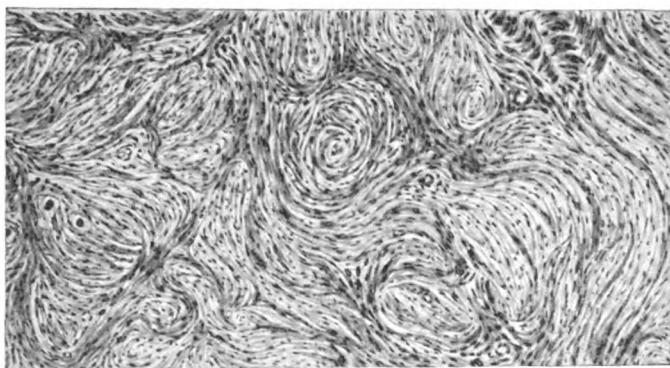


FIG. 4.
Spindle-celled sarcoma of scalp. Magnif., 90.

A moment spent in comparing Figs. 2 and 3 will not be wasted. The former illustrates a tissue in which growth has remained within physiological limits, the latter one in which it has become atypical. Whatever be our opinion of the specimen from which Fig. 2 was taken, whether we incline to regard it as an accessory organ or a tumour, there is no doubt of Fig. 3. Yet both reproduce the fundamental structure of the breast, but with unequal success. This is the only real difference between them. They are both of them, in my opinion, malformations and tumours combined.

I might have here reproduced a drawing of an intra-canalicular mammary fibro-adenoma as a further illustration. But I do not wish unduly to multiply the figures; besides, they are very tedious to draw. In these tumours the tubules become lengthened and distorted beyond recognition, and are often

squeezed out of existence by an excessive and irregular proliferation of the loose stroma immediately surrounding them. It shows, at the same time, a marked tendency to undergo oedematous changes, and dominates the picture. But the lobular structure of the breast is nevertheless preserved, and the same fundamental style of architecture is again evident. It has only become yet more distorted.

We have hitherto investigated innocent tumours, but will now turn to a malignant one, and choose for our next example one of the simplest kind, namely, a sarcoma. Fig. 4 represents the central parts of a spindle-celled sarcoma of the scalp. It consists of irregular sheets of fusiform cells. In places where proliferation was active they are large, with big, darkly stained

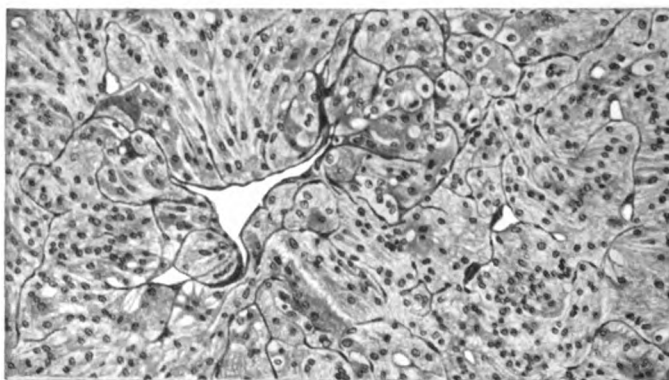


FIG. 5.

Parathyroid adenoma within the thyroid. Magnif., 180.

nuclei. They, however, quickly shade off into whorls of elongated fibrillæ, the nuclei among which are smaller and narrower. The drawing illustrates the fact that the central and therefore oldest parts of all malignant tumours undergo a certain amount of differentiation. The whorled arrangement is most characteristic, and recapitulates the tendency—the function—of connective tissue to surround and form sheaths for other structures. This tendency is well brought out in the drawing, although the whorls are irregular and surround nothing in particular. It would be difficult definitely to state, from a view of this field alone, that it does not represent inflammatory granulation tissue at a certain stage of organisation and fibrosis. I maintain that the drawing clearly demonstrates the fact that one of the very simplest of tumours has retained the characteristic architecture of the normal tissue to which it corresponds. It is young

cellular, and indeed malignant, granulation tissue quite as much as a spindle celled sarcoma.

Fig. 5 represents a part of an adenoma of a parathyroid, which was imbedded in the lower lobe of the thyroid, from which it was separated by a distinct fibrous capsule. As Mr. G. Massie is preparing the case for publication, I use it here merely to show the perfect manner in which the structure of the parathyroid has been retained in this tumour, which was several thousand times the size of that organ. It consists of broad columns of cells, with very indistinct outlines and with a granular, vacuolated cytoplasm. The nuclei are round or oval, usually with a distinct nucleolus, and vary somewhat in size. The columns are incompletely separated from each other by extremely delicate connective tissue septa, in which a few elongated nuclei are visible. The parenchyma of the tumour has a distinct tendency to be arranged at right angles to the septa. Every here and there the latter split to enclose thin-walled blood-vessels. Several of the irregular oxyphile cells, characteristic of the parathyroid, are an obvious feature of the drawing. They are usually opposed to the septa and vessels. To any one who is familiar with the structure of the parathyroids, it is at once apparent that the tumour has very closely indeed imitated the normal gland. The only differences are that the columns are broader, and the vessels therefore less numerous, since the pressure exerted by the bulk of the former has obliterated them, and that the nuclei are more numerous and vary in size. All these differences are nothing more than expression of the enormous amount of proliferation of the tissues of the tumour. They do not in any way contradict the statement that growth has taken place according to the laws that govern that of the normal parathyroid glands. They indicate that it was excessive, but not necessarily disorderly. "Giant parathyroid" is every bit as good a name for this tumour as "adenoma."

Adenomata of the thyroid, and sometimes carcinomata as well, bear the same close similarity to that organ which the tumour we have just discussed bears to the parathyroid. In certain cases it is quite impossible to decide from the microscopic appearances whether we are looking at an adenoma, a normal gland, or a parenchymatous enlargement. I shall have to refer to these tumours again in a future study. I mention them here in order to reiterate the truth that they preserve the architecture of the normal gland in every detail.

My next example is an ordinary keratinising squamous carcinoma of the vulva, a part of a metastasis of which, in an inguinal lymph-gland, is represented by fig. 6. A sheet of

fibrous tissue with large blood vessels bisects the drawing at about its middle. It represents a septum between two lymph-nodes, whose lymphoid parenchyma is shown at the bottom of the figure. The lymph-sinuses at the periphery of these nodes have been infiltrated by the carcinoma, whose cells have destroyed and replaced their endothelium. As the tumour was a freely keratinising one, large masses of horn (not shown in the figure, the spaces occupied by them having been left blank) have accumulated, and have distended its downgrowths. Big spaces have thus been produced. These are lined by the squamous cells of the tumour, which form very definite cutaneous coverings to them, in which a basal layer of more or less columnar germinal cells, a stratum granulosum, and a keratinising layer are apparent

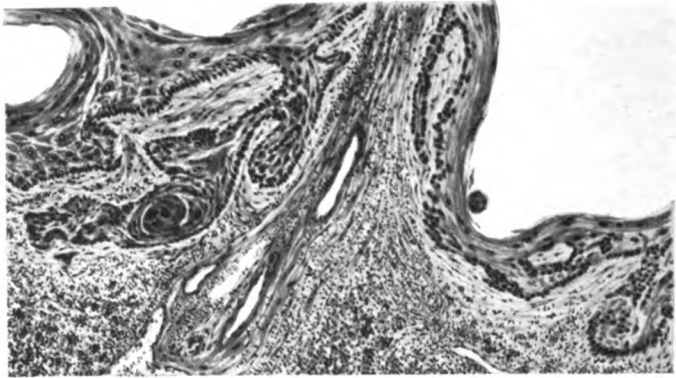


FIG. 6.

Metastasis in lymph-gland of squamous carcinoma of vulva. Magnif., 90.

Although the individual cells vary much in size and shape, thereby proving their blastomatous nature, and the layers are highly irregular, the general effect produced is very similar to the skin. This resemblance is carried still further, since epithelial processes extend downwards. These again are very irregular in size and shape, but nevertheless they resemble distorted papillæ. The cells of this carcinoma, though atypical in appearance and disorderly in growth, have still been able to follow the instinct, if I may use the word, of squamous epithelium to cover naked surfaces and to send down papillæ into the underlying mesenchyme. And this, to my mind, they have accomplished with some considerable degree of success. But they have done yet more. They have exerted a governing or moulding influence on the scanty stroma of the lymph-gland, condensing it into a delicate connective tissue, which forms a distinct

corium on which the epithelium rests. That it is not the result simply of an inflammatory reaction is proved by the almost complete absence of leucocytes and young capillaries—of granulation tissue—in this layer, and indeed in the whole of the section. Such leucocytes as are present in the corium are lymphocytes, and clearly belong to the lymphoid tissue of the gland. The absence of inflammation on the part of the tissues of the gland is a very noticeable feature of the specimen. The lymph-gland may be said to have submitted to the invasion and to the substitution of its endothelium by the epithelium of the carcinoma as a matter of course.

This specimen proves that the cells of the tumour have adhered to the laws of growth of normal epithelium, and that they can, even in a metastasis, perform the functions of this tissue. They can cover surfaces denuded of their endothelium, send papillæ downwards, and mould the pre-existing stroma according to their needs. The term "malignant skin" conveys a much more accurate idea of the nature of the tumour than does "squamous carcinoma."

The absence of inflammatory reaction at the edges of metastases in general is a feature of some interest. It is usually in marked contrast to the fibrosis seen around the primary growth, and often does not make its appearance until necrosis is well advanced. There is evidence to show that the fibrosis that does occur is the result chiefly of the compression and disruption of the tissues by the proliferating cells of the tumour, and that, when it is of a marked inflammatory type, the latter has become infected or undergone extensive necrosis. The foreign-body action of healthy tumours, even when their growth is rapid, is but slight. They are a part of the tissues of the body, and the latter treats them as such. Ovarian "dermoids" illustrate this point nicely. Those parts of their wall that are covered by epidermis possess a corium without signs of inflammation. Beyond the edges of the epithelium the wall consists of an extremely cellular granulation tissue with crowds of giant cells, busily occupied in removing the dead sebaceous material and hairs with which the cavity is filled.

The capsules of innocent tumours are therefore not so much attempts by the tissues to wall them off, as products of the activity of the tumours themselves. In part, no doubt, they are produced by stretching and fibrosis of the surrounding connective tissue, but many are strictly comparable to the capsules of normal organs. Ossifying chondromata, which represent the bulk of peri-articular exostoses, are invariably surrounded by a fibro-cellular capsule, a true perichondrium.

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They increase in size only so long as its cells proliferate and differentiate into cartilage; when they cease to do so the growth of the exostosis comes to an end. This occurs when the bones cease to grow. These tumours and many others possess a true appositional growth, in the sense of Schaper and Cohen,¹¹ and in this respect, as in so many others, do not differ from the normal tissues of the body.

Fig. 6 has shown us that one of the ways in which squamous carcinomata obey the laws that regulate the growth of the epidermis, and in which they prove their essential identity with this tissue, is by forming a definite corium from the connective tissue they happen to come into contact with. We will now

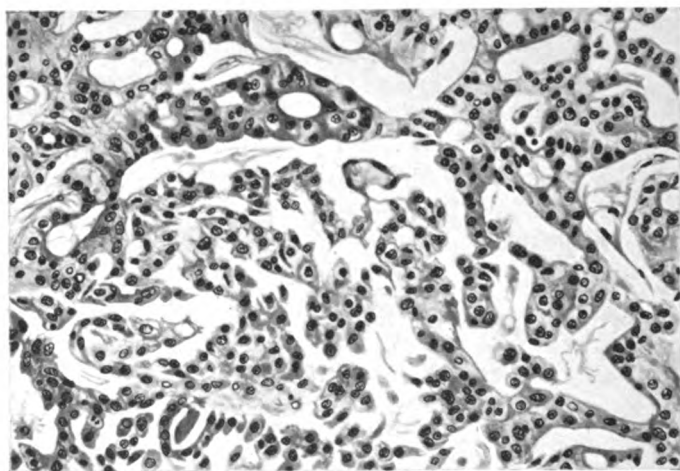


FIG. 7.
Carcinoma of pancreas. Magnif., 230.

compare that drawing with Fig. 7, which represents a tumour of the pancreas. Here we see irregular columns and bands of cells, with vesicular nuclei and indistinct outlines. These cells stick closely together after the manner of an epithelium in many places. They even form irregular lumina, one of which is occupied by a plug of albuminous secretion. But almost everywhere the cells tend to give up the epithelial habit, to become loosened and separated from each other, and to lengthen and to acquire processes at their corners and ends. A few are definitely spindle-shaped.

I am well aware that many would call this tumour an endothelioma on account of this behaviour of its cells. They make the assumption, which it is impossible either to prove or to disprove, that it has grown from the endothelium of the

lymph or blood-vessels of the part. In support hereof they trace connections to the surrounding vessels, that are lined by cells with "intermediate" characters. This in spite of the fact that it is constantly being proclaimed that all tumours grow only by division of their own cells, and that these "intermediate" stages are nothing more than expressions of inflammatory hyperplasia. I know well that in many laboratories endotheliomata are seen by the dozen. I have seen one only during the last eight years, among some 5000 tumours of all descriptions. Tumours so named differ much. One cannot but admire the variety of tissues into which the endothelium can grow. Thus, in the parotid alone, it gives rise to myxomatous tissue and cartilage, as well as to tubules, sheets of cells, and solidly keratinised squamous cell-nests, with keratohyalin and prickle-cells. MacCallum (⁶, p. 928) is right when he regrets that they represent, not a pathological entity, but merely a convenient name, under which atypical tumours, whose structure is often unlike any known tissue, are grouped. Although the nature of many of these tumours has not yet been recognised, that of others is already known. Here again I may instance parotid tumours, of which I shall have plenty to say anon. I therefore banish endotheliomata from these studies for ever, and return to my subject.*

Is the tumour represented by Fig. 7 susceptible of an explanation which agrees with embryological facts? I believe that it is. Although its cells are highly atypical, and although they have lost all resemblance to the epithelium of the pancreas, or to that of any other organ, yet by their habit of growth, their arrangement into sheets and around lumina, they indicate still that they are epithelial. Not only is their structure very atypical, but their behaviour is so too. The conclusion that they have lost, or have not acquired, almost all the characters of an epithelium, is a perfectly legitimate one. Almost, but not quite all. For with the absence or loss of their differentiation, their earliest instincts, to use again this figure of speech, instincts which normally lie dormant or have totally disappeared in epithelial cells after the first period of embryonic life, have reawakened. We see them, in the picture, endeavouring to form mesenchyme. Let it be clearly understood that I say merely that they endeavour to do so. The assertion that they actually succeed is Anathema, and I have no wish to bring the full weight of authority against

* It has frequently been held up against me by my friends that I myself described six endotheliomata some years ago. (*Guy's Hosp. Reports*, lxi. 273, 1907.) I cry: "*Peccavi et passus sum*," and take this opportunity freely to acknowledge my error.

me, should I make it. Retterer,^{9,10} to mention but one of many, has spent the greater part of a long life in an attempt to show that the cutis comes from, and is replaced by, the deeper layers of the epidermis, and has received but scant attention. Nevertheless, the resemblance of our tumour to the appearances seen during the budding off of the mesenchyme is undeniable. We know that the whole of the mesenchyme is derived from epithelium, since the embryo at first consists of nothing else. We also know that hypoblast gives off mesenchyme. I therefore maintain that the appearances seen in this specimen are quite compatible with the teachings of embryology. I believe it to represent a carcinoma of the pancreas, which has either lost its differentiation, or else has never acquired it. Its cells are on the

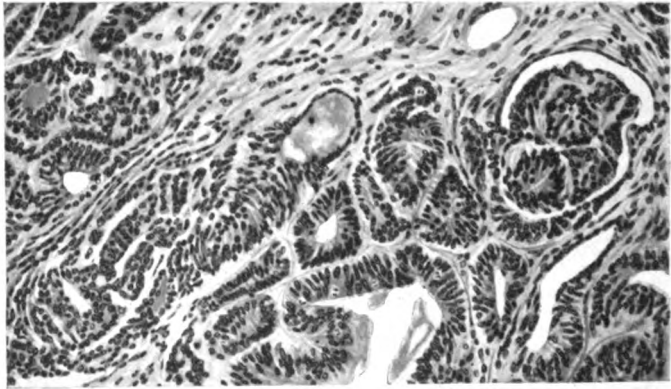


FIG. 8.
Embryonic tumour of kidney. Magnif., 180.

level of the primary hypoblast, and attempt to obey the laws that regulate its growth during the first period of embryonic life.

The reversion to the appearances seen during the development of the tissues is a characteristic feature of most tumours. The cells of their parenchyma have an immature look. But that this is not invariably the case is, I think, sufficiently demonstrated by Figs. 2 and 5, which conform exactly to the structure of the fully differentiated cells of the corresponding tissues. It will be interesting to compare them with Fig. 8, which represents a malignant tumour that habitually recapitulates the normal development of an organ. It is an example of an "embryonic tumour," often called "adeno-sarcoma," of the kidney, a type of neoplasm common enough in children. In Fig. 8 we see, extending obliquely upwards from the left lower corner, an irregular mass of rounded and elongated cells, which

at its edges fuses with the surrounding connective tissue without sharp outlines. It is irregularly split up into bands of compactly placed cells surrounding irregular lumina, the largest of which, just above the centre of the drawing, is lined for the greater part of its circumference by flattened cells, and contains an albuminous hyaline secretion. Other masses of epithelium are represented, in which all stages of lumen formation and condensation of cells to form definite tubules are visible. One of the best defined of these contains an albuminous secretion. Five mitoses are scattered about in its wall. All of them are very similarly orientated in respect to the lumen, and suggest that growth was proceeding in an orderly manner, according to definite laws. Near the right of the drawing is a structure which can instantly be recognised as a developing glomerulus, in which capillary loops have not appeared. The general stroma is cellular and myxomatous. Some of the connective tissue nuclei, by their elongated rod-like shape, suggest young plain muscle fibres.

Opinions have differed as to whether appearances like those described above, which are characteristic of these "embryonic" kidney tumours, are due to lumen formation or to splitting up of preformed tubules and to infiltration of their cells. And indeed, if we limit ourselves to a study of the cells alone, it is quite impossible to decide which of these two views is the true one. It is only when we realise that tumours have an orderly structure, agreeing with the plan on which the normal tissues are built, that we can decide the point. It becomes apparent at once, if we compare them with developing kidneys, that these tumours are nothing more or less than "malignant embryonic kidneys," as Trappe¹³ calls them, since they recapitulate the appearances seen during the development of these organs. Just as in the embryo tubules and glomeruli as well as the stroma develop from the undifferentiated cells of the mesoblast, these same structures are formed from the masses of undifferentiated round cells of these malignant "nephromata."

I believe that I have brought forward sufficient evidence to show that tumours do not differ essentially in their structure and their growth from the other tissues of the body. Although my instances have been few, I have selected them as widely as possible, from typical and atypical, from innocent and malignant tumours. I could easily have multiplied them to any desired extent, since almost any tumour, with the exception of the most atypical of them all, could have been employed to do so. Typical tumours come very close to malformations. So close is this relationship, that it becomes almost or quite

impossible to decide under which of these headings to classify them. Teratomata teach us this, as we shall see presently.

Hitherto I have said but little about the shape and structure of the cells themselves. They differ but in the degree of their perfection, of their differentiation, from normal cells, and this varies within wide limits. The resemblance is usually so close that it forms the basis of our classifications of tumours. Here, however, a word of warning may not be out of place. Instances arise, and not uncommonly, in which this resemblance is purely secondary and accidental. The temptation is great to compare cells of a tumour that have undergone, let us say, extensive fatty changes, with those of an organ whose epithelium physiologically does so, such as the suprarenal cortex, and to conclude that they are actually derived from it. Before such an assumption is permissible, every other possibility must have been rigorously excluded. Especially must it agree with embryological data. If it does not, it is sure to be wrong. For instance, it has been suggested, as a possible explanation of the peculiar cells found in malakoplakia of the bladder, ureter, and renal pelvis, that they have been displaced from the suprarenals, since it is well known that suprarenal rests have a wide distribution along the genito-urinary tract. This distribution depends, however, on the descent of the gonad, and follows its line. The bladder is a part of the cloaca, its trigone a part of the Wolffian duct, and the ureter and pelvis of the kidney arise as a bud from the latter. This grows forwards from its posterior end. As the Wolffian duct is present as a closed tube long before the suprarenal appears, it is quite impossible for cells of the latter to be found within its lumen.

Extraordinary conclusions have been drawn from comparisons of malformations and tumours with normal organs of other animals. A rodent ancestry has been ascribed to man on the strength of certain hairy polypoid tumours which are occasionally attached to the palate or fauces; simply because rabbits have a patch of fur on each side of their cheeks. The only true explanation of such anomalies is to be found in the development of the individual. These polypi are teratomata, and differ from epignathi and double monsters only in the simplicity of their structure. They can be explained as malformations of the individual, but never as analogues to structures found in a group of mammals that is known to be nowhere near the line of descent of the human species. Such loose speculations can only serve to bring Morbid Anatomy into discredit.

A few words about the mitoses found in tumours may not be out of place here. The view that they differ from those of

normal tissues and that they correspond to the maturation divisions of the sex cells, has been abandoned long ago, and need not concern us. The mitoses of rapidly growing tumours are often irregular and atypical, uni- and tri-polar figures, as well as extruded chromosomes and asymmetrical figures, being met with. But they are not characteristic of tumours, since they occur in regenerative hyperplasias as well. Thus, Heitzmann⁵ has recently described and figured them all in the liver of a case of corrosive sublimate poisoning. His conclusion, that they are the result of the damage done to the cells by the poison, can be applied to tumours, the vitality of whose cells is often low.

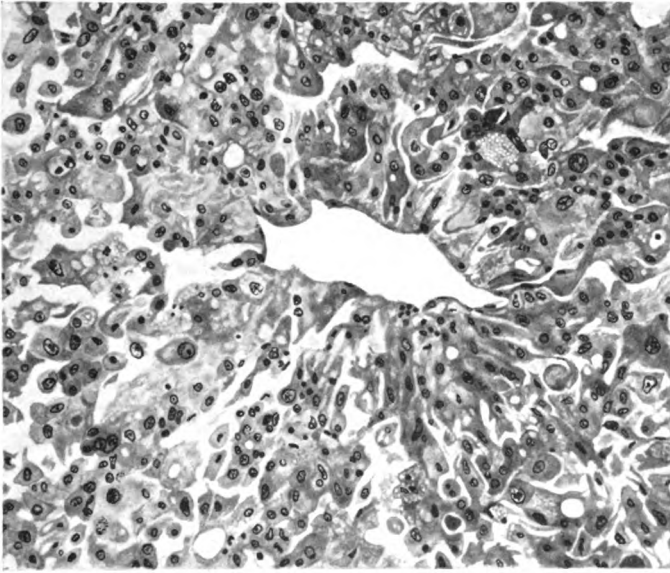


FIG. 9.
Carcinoma of liver. Magnif., 155.

It has frequently been urged that tumours perform no functions, or that, if they do, they are of no use and only accidental. If, for the moment, we leave the question of usefulness out of consideration, we come across a surprising number of instances in which there is histological evidence of a considerable amount of physiological activity in tumours. Fig. 9 represents a primary carcinoma of the liver. A small globule of bile can be seen near its lower border, and one half of another on the extreme right of this edge.* Even the metastases of these

* I had originally made this drawing for another purpose. The presence of these globules may therefore be almost called accidental. The fact of their being nearly out of the picture makes them all the more convincing.

tumours have been known to secrete bile. I have already alluded to the delicate functional balance in the lactating adenoma of the breast in Fig. 2, that is suggested by the presence of resting among the secreting mammary acini. The cells of the squamous carcinoma in Fig. 6 had performed the function of the epidermis of forming a protective covering of horn, and this within a lymph-gland. The primary growth also subverted the entirely useful function of covering the connective tissue. If, owing to ulceration, it was but imperfectly performed, this was an accident for which the tumour ought not to be blamed.

When we regard the ganglion in Fig. 1, what right have we to assert that so highly developed an organ did not functionate to the same extent to which it would have done in a foetus of the age corresponding to its degree of differentiation? I believe that we have no right to do so, since I regard structure and function as a biological entity. We cannot even assert that the function was an entirely useless one, since the teratoma contained many organs. That it was useless from the point of view of the bearer is, of course, obvious. But this is not a fair way of looking at the tumour. After all, the foetus in utero does not concern itself about the well-being of its mother.

This brings me to the point of view of the functions of tumours which surely is the correct one. They try their best, in almost every case, to perform those of the corresponding normal tissues. That they frequently fail, or succeed but imperfectly, is the result of imperfection of structure. They are malformations, and agree in this respect with others. The degree of perfection to which a tumour can functionate depends primarily on the amount of differentiation its cells have undergone. It is most perfect when this reaches the standard of the normal cells of the body, as in Fig. 2. But even in a malignant tumour, such as the one represented in Fig. 9, in which there is a good deal of irregularity in the size of the nuclei and the shape of the cells, as well as in their grouping, evidences of function are apparent. Another reason why function is often aborted is to be found in the absence of ducts and in accidents of position. In such cases the secretion, when formed, accumulates and destroys the cells of the tumour, with the production of cysts.

Tumours of the ductless glands, whose secretion passes directly into the circulation, are in a better position to functionate than are those of most other organs. We therefore meet with some of the most striking instances, not only of a physiological, but often of an excessive secretion in them. Thus carcinomata of the suprarenal cortex give rise to a very definite group of symptoms, the chief of which are sexual precocity in children,

and an abnormal growth of hair and a general approach to the characters of the opposite sex in women. Glynn⁴ has shown that these symptoms are due to hypersecretion of the suprarenal cortex (whose bulk is of course enormously increased by its epithelial new growths), since they also occur in simple hypertrophies of these glands. The result, far from being useful, is generally fatal. But this does not alter the fact that the cells of these tumours perform functions, which in themselves are physiological.

The thyroid furnishes still better instances of this. Its malignant epithelial tumours, and even their metastases, produce colloid, which is no doubt the matrix to which the internal secretion of the gland is bound. But they secrete the latter as well. I must here quote once more the famous case of v. Eiselsberg.³ A large adenomatous colloid goitre was totally extirpated from a woman, who then developed typical symptoms of myxœdema. These diminished in intensity in proportion to the growth of a tumour of the sternum, which made its appearance two years later. Four years after the thyroidectomy it had reached a considerable size, and the signs of cachexia thyreopriva had entirely disappeared. As the tumour caused much discomfort it was removed, and was found to be a columnar celled carcinoma with small drops of colloid in its tubules, but without the structure of the normal thyroid. The symptoms of myxœdema now reappeared, and remained uninfluenced by a second tumour, which appeared in the scapula. I must add that the tumour of the sternum grew slowly at first, with slight increases in size at each menstrual period and corresponding diminutions between them. Later its growth became much more rapid.

Simple parenchymatous goitres and innocent adenomata of the thyroid have given rise to secondary deposits in a number of well-authenticated cases; v. Eiselsberg's case is an instance of a carcinomatous metastasis in such a one. It shows in the most convincing manner that a metastasis is capable of performing the functions of a normal gland, and of relieving the symptoms caused by its removal. It completely upsets all statements that tumours subserve no useful functions, and gives the strongest support to my contention that the imperfection of function is, in the majority of cases at least, purely an accident.

Tumours are accused of being autonomous and of deriving their blood supply and nourishment from the resources of the body. But what else can any large mass of cells be than an autonomous tumour? Take the liver or the thyroid as examples. They are developed from certain buds of epithelium, which

proliferate and give rise to the whole of the parenchyma of the gland. During their development they enter, push aside, and mould to their needs the surrounding mesenchyme, and form connections with the blood vessels. They acquire a capsule and are then quite as independent of the rest of the body as many tumours. If the thyroid, for instance, were present in only a certain proportion of individuals, and if we knew less about its functions than we do, it would surely be called a tumour by every one. Or, to state my case better, if cystomata of the ovaries, with their abundant pseudo-mucinous secretion, were present in all women, would we not regard them as organs with unknown functions? Just as a tumour derives its nourish-

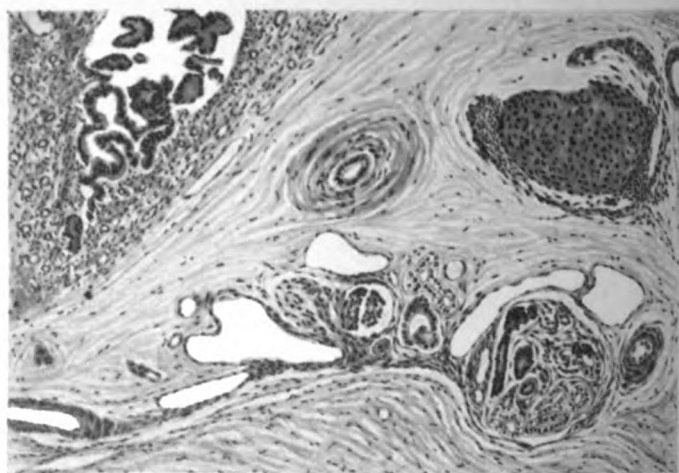


FIG. 10.

Composite drawing of cystic horse-shoe kidney of symmelian monster. Magnif., 90.

ment from the body, so does every normal organ. Inasmuch as the liver uses a certain amount of food to enable its cells to perform their functions, it lives at the expense of the total available food supply in the same sense as does a tumour. Since the liver is indispensable to the well-being of the individual, this behaviour on its part is universally lauded. Then why condemn a tumour which, as I have tried to show, generally does its best to be useful, and in some cases actually succeeds in being so, because it does the same?

I have neglected to emphasise in this paper the phenomena that characterise malignancy, and may thus be blamed for having taken too favourable a view of tumours. But these are not shared by them all, and I hope to devote a future study to them.

In conclusion, I wish to revert to the close similarity of many

tumours to malformations, to their identity, in fact. For this purpose I have combined, in Fig. 10, several parts of a cystic horse-shoe kidney (? mesonephros) of a symelican monster. Its thick capsule occupies the lower edge of the drawing. Just above it we see a glomerulus and a couple of tubules among the thin-walled vessels of the fibrous stroma of the organ. To their right is a rounded, perfectly isolated and encapsulated mass of tubules, lined by different kinds of epithelium. It has all the characters of a minute adenoma. At about the middle of the drawing we see a large tubule surrounded by a well-defined sheath of concentric fibro-muscular bundles. The upper left-hand corner is occupied by granulation tissue, in which there are bands of desquamated and proliferated epithelial cells, of an appearance which we generally regard as atypical and blastomatous. Its resemblance to a papillary carcinoma cannot be denied. (The nodule of young hyaline cartilage does not concern us for the moment.) In this malformed organ we thus have represented three tumours *en miniature*: an adenoma, an adeno-myo-fibroma, and a carcinoma. Let us now try to explain these three little tumours from the point of view of the malformation itself. The little adenoma becomes an attempt at normal differentiation, at tubule formation. It is a little kidney anlage,* which was perhaps rendered possible by a local looseness of the tough fibrous stroma at this spot. It was made the best use of by the organ, and is a very creditable attempt under unfavourable circumstances. The fibro-muscular wall of the big tubule is merely a repetition, or perhaps a very slight exaggeration of the normal envelope of the large tubules in the pyramids of all developing kidneys. Both these structures strike us as being unusual solely because of their isolation. The little carcinoma can be explained as a proliferation of the epithelium of a tubule in response to the stimulus of the liberal blood supply of the granulation tissue. Its proliferation had become excessive, much above the normal in extent, and was just beginning to get beyond the control of the malformed organ as a whole. Here then we have nothing more than three little malformations within the big one. Two of them are behaving after the manner of normal tissues, the third has undergone blastomatous growth. These little malformations are due to arrests of development. The first two are what Albrecht¹ called "hamartomata,"† the third is one of his "hamarto-

* There is no word in the English language equivalent to this German one. Our nearest approach is "rudiment" or "germ," both of them unsatisfactory. I cannot bring myself to employ the horrid word "primordium," which has of late been adopted by embryologists.

† From ἀμαρτάνω, to go wrong.

blastomata." Among the hamartomata he includes all arrests of development, in which growth has remained within physiological limits. They present themselves to us as isolated nodules and tumours. He points out that many so-called innocent neoplasms are hamartomata. One of the instances he names is fibro-adenoma of the breast. I have already shown (fig. 3) its close resemblance to aborted malformed mammary tissue. Hamartoblastomata are malformations in which growth has exceeded physiological limits, and has become blastomatous.

Albrecht regarded the majority of hamartomata as malformations that have arisen during embryonic life, although he admitted that some of them could be produced at any age as a result of injury, irritation, etc. This cannot be decided without some knowledge of malformations in general, including accessory organs and persistent embryonic remains. I therefore propose to devote the next of these studies to a review of these conditions.

CONCLUSIONS

Tumours, in their structure, their functions, and the manner of their growth, do not differ essentially from other tissues, and obey the laws that govern their behaviour. They are merely less perfect. In this respect they resemble malformations.

This resemblance is often so close, that it becomes apparent that they merge into each other. In fact, tumours are malformations.

Since tumours are malformations, they help to elucidate some of the unsolved problems of normal growth.

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- ¹³ Trappe : *Frankfurter Ztschr. f. Path.*, i. 130, 1907.

IMPACTED UPPER WISDOM TOOTH

By R. P. ROWLANDS, M.S., Surgeon to Guy's Hospital; with remarks by
MONTAGU F. HOPSON, L.D.S., Dental Surgeon to Guy's Hospital.

MARY L., aged twenty-five, was sent to me in January 1920 for pain and trismus due to an impacted right upper wisdom tooth.

In March 1919 she suffered pain in the right side of the face, chiefly about the angle of the jaw, but radiating along the branches of the second and third divisions of the fifth nerve. The right lower second molar was extracted in March 1919 with the object of giving more room for the lower wisdom tooth, which had not erupted. This gave no relief of the pain, which was increased by opening the mouth for eating, singing and talking. In July 1919 the pain became worse, and was most severe below and in front of the right temporo-mandibular joint. A radiogram, taken in November 1919, showed an unerupted right upper wisdom tooth. The right lower wisdom tooth was extracted without benefit. The patient was re-admitted into a hospital and extraction of the right upper wisdom tooth was discussed, but considered unwise, as it would be very difficult and unlikely to relieve the symptoms. The radiogram showed the shadow of the tooth a little above and behind the second upper molar.

In February 1920 the patient was admitted to Guy's Hospital, and an incision was made horizontally through the mucous membrane just below the reflexion of the cheek to the upper jaw. The outer and posterior wall of the antrum was gradually chiselled away, but no tooth could be found where the radiogram indicated. The second upper molar was removed to give more room, and a finger was introduced into the antrum, but the tooth was not felt. With the aid of a head-lamp, a good view of the sinus was obtained after removing more bone, but no sign of the tooth was discovered, and the operation was reluctantly abandoned.

The symptoms continued and pus issued from the antrum.

Some months later another radiogram showed the tooth in the same position (Fig. 1).

Stereoscopic radiograms taken horizontally from side to side and before backwards then showed that the tooth was much

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higher and further back than the previous radiograms indicated (Figs. 2 and 3). All the latter had been taken obliquely from above downwards and inwards and had grievously misled us.

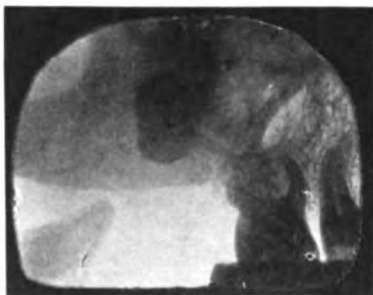


FIG. 1.

The right upper wisdom tooth is shown just above and behind the site of the second molar. It was really much higher.

Another operation was advised and carried out at Guy's Hospital on October 25. A similar incision was made and the



FIG. 2.

The upper wisdom tooth is shown upside down above the level of the palate.

cheek was well retracted. The antrum was opened and inspissated, foul pus evacuated; the dense upper part of the posterior wall of the antrum was chiselled away and the tooth found

firmly embedded in dense bone. It was removed with some difficulty owing to its high position and firm fixation. A large opening was made from the antrum low down into the nose, and pus drained away for some weeks.

Very soon the patient was able to open her mouth much better and without causing the characteristic pain, which had probably been caused by the direct impact of the coronoid process against the maxilla when the tooth was impacted.

The case is considered worthy of recording because :—

(1) The impaction of an upper wisdom tooth in the unusual

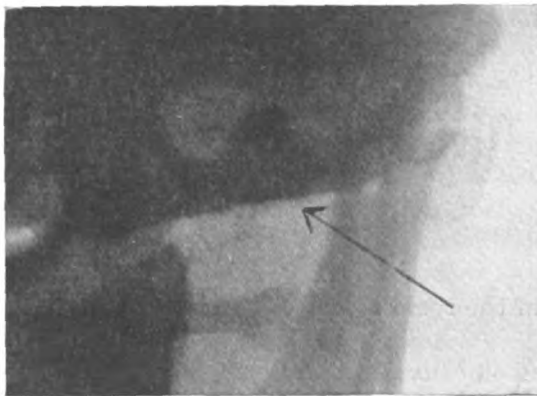


FIG. 3.

The wisdom tooth is shown above the level of the zygma in the floor of the orbit.

situation at the junction of the posterior wall and the roof of the antrum must be exceedingly rare.

(2) The radiograms taken in the usual oblique manner misled us seriously, the tooth being found at least an inch higher than the pictures indicated. It is clear that stereoscopic pictures, taken in two planes, are necessary before undertaking an operation for the removal of an impacted upper wisdom tooth.

(3) The crown of the tooth was directed upwards and outwards.

REMARKS BY MONTAGU F. HOPSON.

IRREGULARITIES in the position of teeth are quite common, and instances of their total misplacement outside the normal dental arch are not infrequently met with. The tooth most commonly involved in total misplacement is the maxillary canine, but any tooth of the series may be so misplaced, and occasionally it is found to be completely inverted.

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Thus cases have been recorded of incisors and canines erupting into the nasal cavity. In the John Hunter Collection in the museum of the Royal College of Surgeons is a beautiful specimen of a canine erupting into the maxillary sinus, and Gravers¹ has figured another specimen, in which both canines were situated with the tips of their crowns in close relation with the inner and lower borders of the orbital margins.

The vagaries in this respect of the mandibular third molars are notorious. I have recorded a case in which this tooth was completely inverted,² and another in which it was situated just beneath the tip of the coronoid process of the mandible.³ Colyer⁴ also has a figure showing a mandibular third molar erupting externally at the angle of the jaw.

Cryer⁵ cites and figures two cases somewhat similar to that of Mr. Rowlands. In one the maxillary third molar is inverted, but apparently placed at a much lower level than in his patient; in the other the tooth is approximately in the same position, but the crown is directed backwards. Colyer⁶ records another case, in which this tooth was inverted and held between the roots of the second molar, and I have seen an instance of its crown being directed forwards, a rare misplacement, and producing absorption of the roots of the second molar.

The common causes of abnormalities in position of teeth are (a) the early loss or prolonged retention of deciduous predecessors; (b) the presence of supernumerary teeth; (c) displacement of a developing tooth, the result of trauma; and (d) interference with those factors upon which the normal growth of the jaws depend. In those cases, however, in which a tooth is totally misplaced from the dental arch, the above causes may be absent and we are driven to seek some other explanation.

Apart from instances in which a developing tooth is pushed out of position by the presence of a neoplasm, or there is some gross developmental defect, such as cleft palate, the cause is probably to be found in some aberration in the budding of the primary tooth-band. Thus in the case under consideration the bud for the enamel-organ of the maxillary third molar is normally given off from the backward prolongation of the tooth-band at the third year. Should the budding be delayed, or should the tooth-band undergo an undue increase in its backward growth, the enamel-organ might quite easily be placed in an abnormal position. The normal position of the germ of the maxillary third molar at the time of its appearance is above and behind the developing second molar at the outer side of the lower and external angle of the maxillary sinus. Further it is

to be remembered that calcification of this tooth does not commence until the tenth year, a very much longer interval between the first appearance of the germ and the beginning of calcification than occurs with any other tooth. As the tooth forms, its crown is normally directed downwards, backwards and outwards. The accompanying diagram (Fig. 4), modified as suggested by Campion from a figure of Keith's, shows the growth of the maxillary sinus and the part it plays in moving successive molars into position.

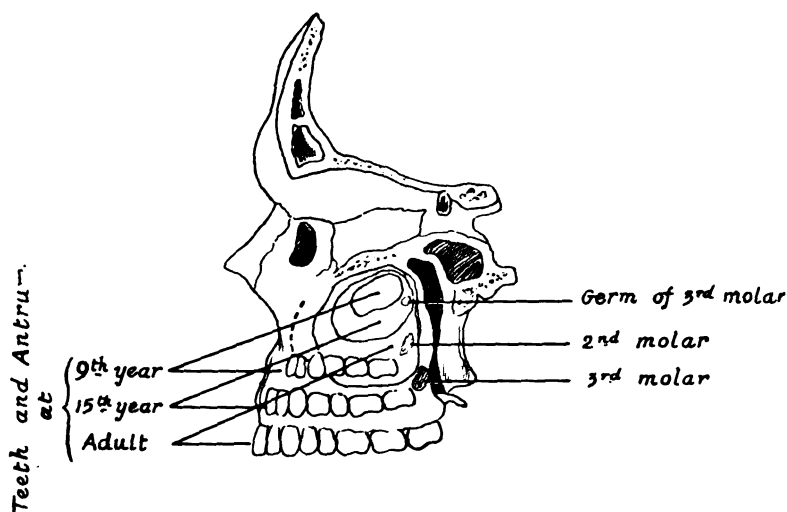


FIG. 4.

Diagram of Relation of Teeth to Antrum.

If then the original bud for the tooth-germ, owing to some undue prolongation backwards of the tooth-band, was given off higher up than usual, or its actual formation was delayed, it would account for the situation of the tooth, and its inversion was probably due to the bud itself being given off upside down. Finally it is to be noted that although the patient was twenty-five years of age, only about half of the roots of the tooth were formed, but in other respects it was normal in size and shape.

REFERENCES

- ¹ M. H. Cryer, *Internal Anatomy of the Face*, Fig. 147, 1917.
- ² M. F. Hopson, *Trans. Odont. Soc. Gt. Brit.*, xxxix, 228, 1907.
- ³ M. F. Hopson, *Proc. Roy. Soc. Med.*, xiii, *Odont. Sect.*, p. 76, 1920.
- ⁴ Sir Frank Colyer, *Dental Surgery and Pathology*, Fig. 189, 1919.
- ⁵ M. H. Cryer, *Internal Anatomy of the Face*, Figs. 150 and 142, 1917.
- ⁶ Sir Frank Colyer, *Dental Surgery and Pathology*, Fig. 171, 1919.

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STUDY OF A CASE OF SINO-AURICULAR DEPRESSION (S.A. HEART-BLOCK) AND ITS BEARING ON THE GENESIS OF THE HEART-BEAT *

By E. P. POULTON, M.D., Beit Memorial Research Fellow, Assistant Physician,
Guy's Hospital, and G. B. DOWLING, M.B., Medical Registrar,
Guy's Hospital.

SINO-AURICULAR block is rather an uncommon condition. It is diagnosed when the heart shows irregularities, superposed on a dominant rhythm, a complete heart-beat being missed out at intervals. Sometimes the pauses are filled with ventricular beats, having a supraventricular origin, and these are looked upon as due to the escape of the ventricle (Levine¹). Although there is no definite evidence that the sinus really is active during the pauses, this is assumed from the fact that the dominant rhythm is the same before and after the pauses. The explanation given is that the sinus is generating impulses at regular intervals, but that sometimes there is blocking at the sinus, so that the impulse does not reach the auricle or ventricle. Levine found that the irregularity was emphasised as the result of exercise.

The first case of sino-auricular block was described by Mackenzie,² and later Wenckebach³ suggested the name on the analogy of auricular-ventricular block. Lewis⁴ has recently reviewed the whole subject in detail.

The present case has been studied in very much greater detail than other cases, and certain new deductions have been made.

By using a paper camera, electrocardiograms (E.C.G.) of many successive heart-beats have been obtained. All the early E.C.G.s were obtained by placing the limbs moistened with saline in contact with broad copper plates, since satisfactory non-polarisable electrodes were not forthcoming at the time. Lewis⁵ has pointed out that the E.C.G. may be distorted under these conditions. Since, however, conclusions have not been drawn from the shape of the complexes, but from their time relations, these errors will not affect the results. Quite recently, in July 1920, we have examined the patient with non-polarisable electrodes and the main features of the original tracings have

* The expenses of this investigation were defrayed by a Government Grant from the Royal Society.

been confirmed. The polygraph has also been extensively used. We should like to thank Sir. T. Lewis for allowing us to use his electrocardiograph on one occasion in an emergency.

The chief conclusions we have come to are that the so-called ventricular escapes owe their origin to electrical disturbances arising in the sinus. This has an important bearing on the origin of the normal heart-beat.

The patient, E. J., was 23 years old and unmarried, and was a ward-maid at Guy's Hospital. She underwent the usual routine medical examination and was passed as medically sound in March 1918. On July 6, 1918, she was admitted into Mary ward under Dr. Shaw, suffering from an attack of left basal lobar pneumonia, thought possibly to have been influenzal in origin. Upon admission her temperature was 102.6° , respirations 28, while attention was drawn to the fact that her pulse was 72 only. The urine contained a trace of albumen. There was a slight murmur. The cardiac impulse was just outside the nipple. Four days after admission, while the patient's temperature was 101° , her pulse was 44. On July 10 her temperature fell by crisis. From this moment extreme slowness of the pulse, together with irregularity, became evident. Following the crisis the patient became rather drowsy and three days later she developed suddenly a left-sided hemiplegia, involving the side of the face and both limbs. There was no optic neuritis. On July 18 the pulse was taken hourly over a period of 36 hours. The rate varied during this time between 26 and 58. The hemiplegia was considered to be due to embolism from the left auricle owing to stagnation of the blood stream. It soon began to show signs of improvement, and in a few weeks every trace of it had disappeared. The pulse during her stay in hospital continued to show the same slowness and irregularity, and this was recognised by the electrocardiograph as being due to sino-auricular block. It was usually slower during the night than during the day, and liable to become faster towards the evening. While resting it was never faster than 66 and never slower than 20. Pauses of as long as 10 seconds were counted by the sister of the ward on several occasions. Such long pauses were fairly frequent in the earlier days of the illness, but they became less frequent later on. The patient herself was quite unconscious of her slow pulse, and stated that she was unaware of the long pauses. She certainly never showed any signs of distress, and except for a rather lethargic condition appeared to be perfectly well. On December 22, 1918, just before she left hospital, her weight was 108 lb. and her stem length was 80.4 cm. The width of the heart was found to be

18.8 cm. by teleradiography, indicating that the heart was considerably enlarged. Her systolic blood-pressure was 130 mm. She was re-admitted on June 26, 1920, for further examination. She had in the meantime married. She complained of gradually increasing shortness of breath, occasional giddiness and faintness, and felt exhaustion on exercise. Her weight was 95 lb., the stem length 79.5 cm. and the width of the heart was found to be exactly the same as on the last occasion, viz. 13.8 cm. There was a faint apical systolic bruit. The radial artery felt remarkably thick; the systolic blood-pressure was now 255 mm. and the diastolic 130 mm. This was confirmed on several occasions. There was albumen in the urine. There was a flame-shaped hæmorrhage on the right retina, and numerous small, sharply defined white spots on the left retina. The pulse was usually between 49 and 50, the limits being 30 and 60. Electrocardiograms showed that the mechanism of the heart-beat was unaltered.

The obvious explanation of the enlargement of the heart was that it compensated for the slow rate, it being necessary for the heart to deliver a larger volume of blood at each beat. The high blood-pressure is not so easy to explain. The remarkable fact about it was that it had risen permanently from 130 to 255 mm. in eighteen months. We have never heard of so rapid a rise before. It is hardly probable that this high pressure occurring in a young subject was quite independent of the cardiac condition. On the other hand, when a period of complete heart-block with slow pulse comes on suddenly, the systolic pressure is raised and the diastolic pressure lowered, so that the mean pressure remains about the same. Similarly in our case when the heart suddenly became slow the systolic blood-pressure was 130 mm., which was rather higher than would be expected after an uncomplicated attack of pneumonia. However, it is conceivable that, given a heart beating permanently at a very slow rate, arterial changes may supervene. We know of no data for the blood-pressure in cases of complete A-V heart-block which have lasted some months or some years. Possibly the undue stretching and relaxation of the elastic tissue in the arteries may cause it to wear out and become replaced by fibrous tissue. If such were the case the blood-pressure might rise, and in addition secondary arteriosclerotic changes in the kidneys and retinæ might be expected.

GRAPHIC RECORDS

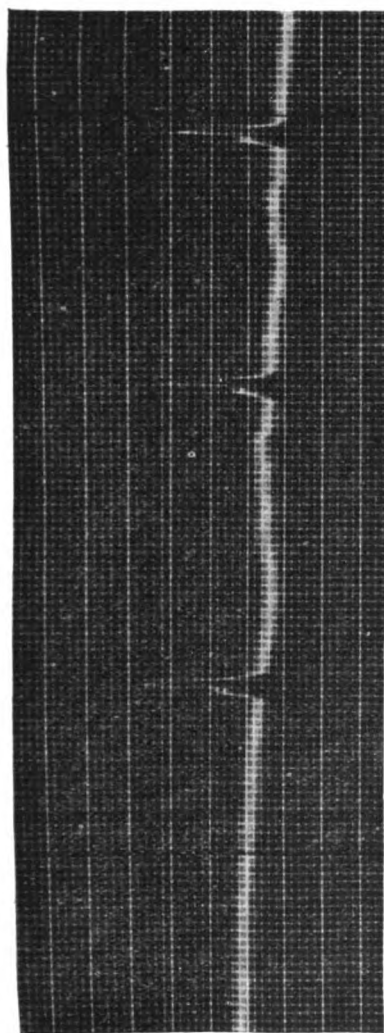
Simultaneous jugular pulse tracings and E.C.G.s were taken on one occasion, and Fig. 1 illustrates the typical features of

the condition. The first beat shown is supraventricular, and this followed 1.66" after the R rise of the preceding beat, which was perfectly normal. The jugular pulse shows that the *a* wave was absent. It could not have coincided with the small C wave, because, if so, the latter would have been much larger. Then follow two normal beats, the intervals being 0.76" and 0.62". There is then a pause of 1.70" followed by a supraventricular beat and then a normal beat 0.64" later. Another normal beat (not shown) followed after the same interval; then there was a pause of 1.76" followed by a normal beat. It will be noticed that the pauses are about three times as long as the shorter intervals, which represent the dominant rhythm. The ventricular complex has a splintered summit—so-called arborisation block, the significance of which is doubtful. This was a fairly constant feature.

It is quite likely that the term sino-auricular block is an incorrect explanation of the actual state of affairs. It is easy to imagine an increased resistance in the A-V bundle which causes delay in the excitation wave or its complete blocking. The sino-auricular node is, however, a group of special cells surrounded on all sides by auricular muscle, so that the area across which the impulse passes must be comparatively large. It is much easier to imagine that the failure of the auricle to respond is due to the impulse from the node being too weak, rather than the occurrence of an increased resistance over such a wide area. However, this cannot be the whole explanation. In the ordinary healthy adult at rest the heart is perfectly regular. If for one beat the sinus failed to excite the auricle, the corresponding pause would be exactly twice the length of the normal interval. In the present case in many instances this is only approximately the case, and it is necessary to infer that there is in addition some irregularity in the initiation of the beat at the sinus—an irregularity that bears no relation to respiration. This has been pointed out previously by Levine and others.

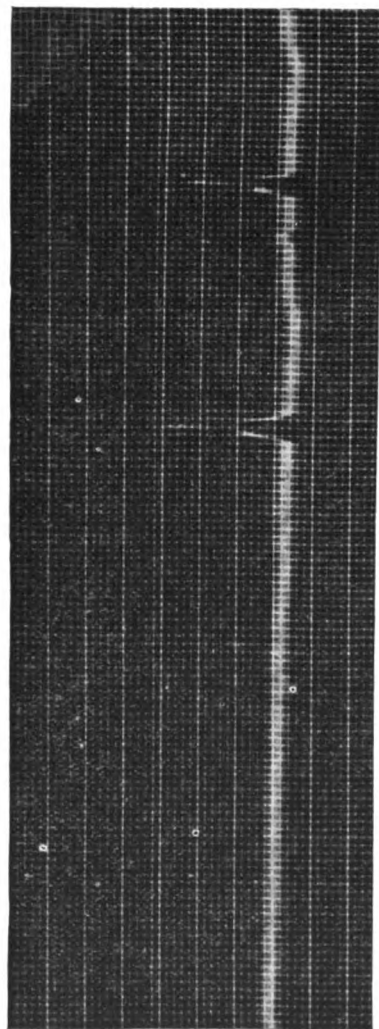
Statistical proof has been obtained that the irregularities can be explained by the dropping of auricular beats. All the intervals immediately following normal and supraventricular beats and preceding all the normal beats in the tracings, have been measured in 25ths of a second. They are placed along the abscissæ in Figs. 2 and 3 and the number of beats are placed along the ordinates. The tracings have been found to fall into two groups represented by the two figures. The curve in Fig. 2 is made up of a number of summits of different heights. The first rise stretches from 10 to 18 with a maximum (the mode) at

Lead III.

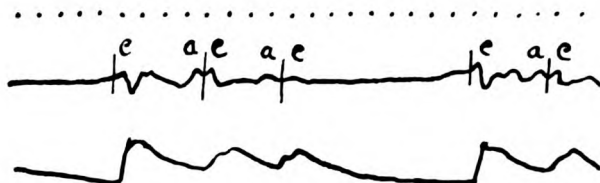
R-R intervals 41.5
in $\frac{1}{3}$ "

15.5

19



16

47.5
Fig. 1.Time in $\frac{1}{30}$ ".Time in $\frac{1}{30}$ "; Jugular tracing; Radial tracing.

14/25ths of a second. This represents all the shorter intervals which form the dominant rhythm of the tracings. The longer intervals are shown in the rest of the figure. On the supposition that these are due to dropped beats, in the cases where one beat is dropped the distribution should lie between 20 and 36, with

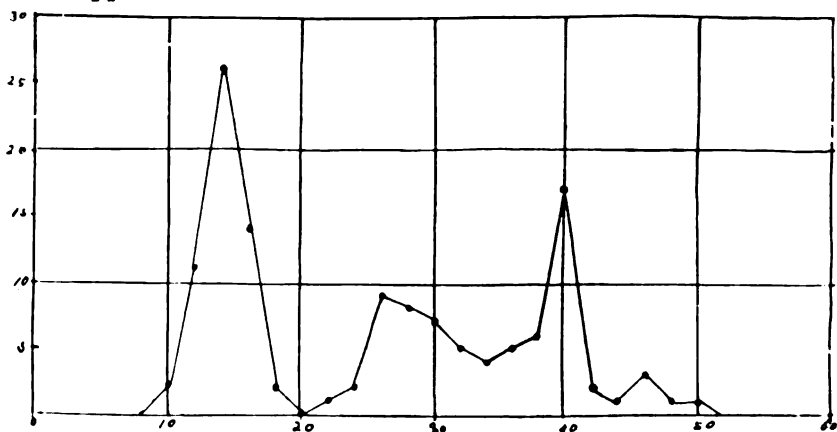


FIG. 2.

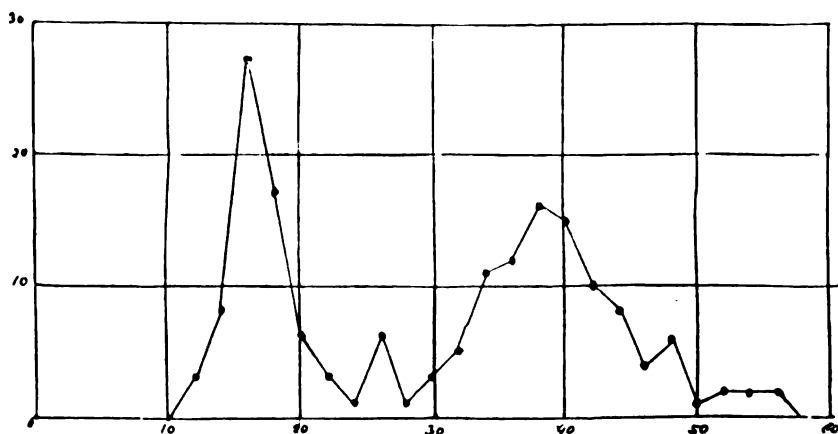


FIG. 3.

To show the distribution of normal heart-beats in the tracings.

Ordinate: No. of normal beats.

Abscissa: R—R intervals between normal beats.

a maximum at 28; *i. e.* double the former values, and this corresponds pretty closely with the rise in the curve shown in the figure, the second peak actually occurring at 26. When two beats are dropped the distributions should lie between 30 and 54 with a maximum at 42, thus overlapping the distribution corresponding to one dropped beat. The third peak actually occurs at 40. The normal beats in the other tracings are shown

in Fig. 3. The mean of the shorter intervals is nearly 17, and the distribution falls between 12 and 22. Theoretically the second summit should lie nearly at 34. It is actually 38; and the third summit should lie at 51. It actually lies at 48. On the whole there is fairly close correspondence.

The most striking point about the distribution curves, is the absence or great scarcity of observations representing intervals one and a half times as long as those of the dominant rhythm. It is this fact that proves that the pauses are to be explained by dropped beats and are not solely due to irregularity in sinus initiation, although it has already been explained that the latter element is also present.

Another way of settling this point is to treat the complexes individually, and see whether a long interval is situated in the immediate neighbourhood of short intervals which are exact sub-multiples of it. All the long intervals preceding normal beats have been examined in this way. In eleven cases there was very close correspondence, and in five the correspondence was fairly close. In eighteen cases the correspondence was not very good. As instances of close correspondence we may take the following sequences of normal beats. In one case the intervals were 46.5, 18, 44.5, 14, 42, 13.5, 42. Here the long intervals are about three times the length of the shorter ones. In another case 17 was followed by 87.5, the multiple being 5. Another example is 15.5, 16, 30.5, 33.5, 38, 13.5. Here the multiple is 2 to begin with and 3 at the end. In other cases Lewis states that the long intervals have been found to be less than twice those of the dominant rhythm. We have observed no such rule in the present case. Where the longer intervals are not exact multiples of the shorter ones, they are just as likely to be too long as they are to be too short.

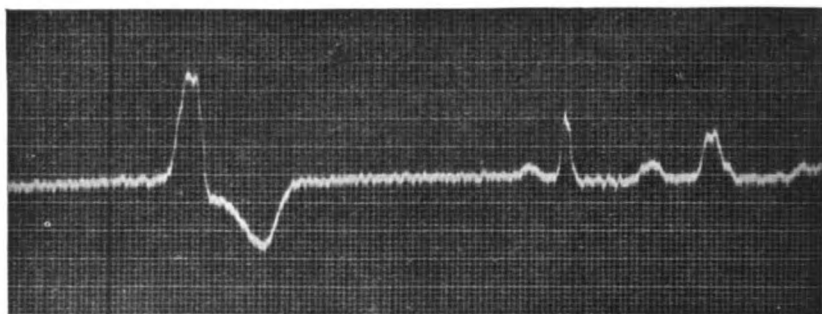
Through the tracings a number of heterogenetic ventricular contractions were seen. They were of two types. (See Figs. 4 and 5.) Thirteen examples of the first type were seen. They were seen specially after the conclusion of exercise, and they were not associated with any auricular contraction. There were two varieties of the second type, and there were twenty-one examples scattered through the tracings. Two of these were idioventricular contractions. They occurred long after the preceding beats, and there was no trace of a P wave. In all the other nineteen cases the interval between the complex and the preceding ventricular complex was short. The mean was 14.5/25ths of a second, the minimum value being 12.5 and the maximum 17.5. This is shown typically in Fig. 4. In sixteen of these cases the aberrant complex was associated with a P wave,

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which was buried in the preceding complex falling on the T elevation. The P-R interval was prolonged in most of these cases. The mean value was 0.216", the minimum being 0.18" and the maximum 0.34".

In the three remaining cases, owing to defective tracings, it was impossible to be certain whether there was a P wave or not. The sixteen beats which were all observed in leads 2 and

Lead II.

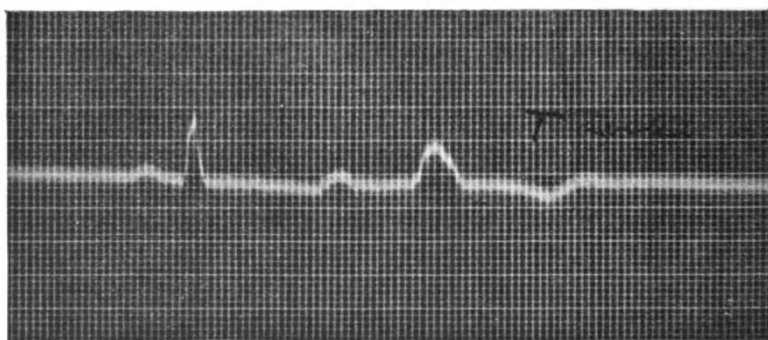


Type 1.
Time in $\frac{1}{80}$ "

FIG. 4.

Type 2.

Lead II.



Type 2.
Time in $\frac{1}{80}$ "

FIG. 5.

3—the leads most commonly used—are clearly due to A-V block, especially affecting certain branches of the bundle, but they are not typical of either of the main branches.

The cause of this block became clear when the intervals between the preceding P waves and the P wave proper to the aberrant complexes were measured. The mean value was found to be 11.66/25ths of a second, the minimum being 8.5 and the

maximum 18. On referring to Figs. 2 and 3 it will be seen that there are 123 beats when the preceding interval between the ventricular complexes is less than 24, this representing the upper limit for beats constituting the dominant rhythm. Of these 123 beats only 16 have intervals less than 18, which happens to be the same number as the beats showing A-V block. The explanation is that when the beats followed at such a short interval the A-V bundle tended to become fatigued so that heart-block often resulted particularly in certain branches of the bundle. Wilson⁶ has shown that aberrant ventricular contractions may follow vagal stimulation in man.

A large number of supraventricular complexes were obtained with no sign of any associated auricular contraction. In the past these have been regarded as ventricular escapes. Examination of the present material showed, however, that the intervals between these complexes were the same as the intervals between the normal beats, or some simple multiple of them. Table I contains all these supraventricular beats and the sequences of beats in which they occur. The numbers refer to the intervals measured from the bottom of the R curve in each case, and expressed as usual in 25ths of a second. N indicates a normal heart-beat; V represents a supraventricular beat. In the last column the intervals before the V's are compared with those before the N's in their immediate neighbourhood, the numbers indicating the proportion between the two. When there is no simple proportion, this fact is indicated by a cypher. Occasionally there is some doubt as to the presence of a simple relationship. This is indicated by a query. For instance, in Record 9 the first three V's are three times the N. Then comes 38 V and 24 V, with no simple relationship to the N on each side of it; but the 15 N may be related to the 44·5 V, and so a query is put. In constructing the Table all intervals immediately following heterogenetic ventricular beats have been omitted, so that the intervals in the Table are strictly comparable, all of them intervening between normal ventricular complexes. The same plan was adopted in constructing Figs. 2 and 3.

The first point to be noted in the Table is that only in Record 16 did a V come after a short interval, *i. e.* 15.* All the

* The direct continuation of this record was as follows: . . . 51·2 V, 17·4 V, 90·7 V, 44·1 V, 16·9 V, 40·4 V, 16·4 V, 43·7 V. In this sequence there were P's buried in the ventricular complex in the case of some of the V's coming after the longer intervals. In this continuation the longer V's are obviously multiples of the shorter intervals. The shorter intervals may be explained by the ventricle responding to succeeding sinus excitations. This did not usually happen, the intervals before the V's in other tracings being multiples of the short normal (N) interval.

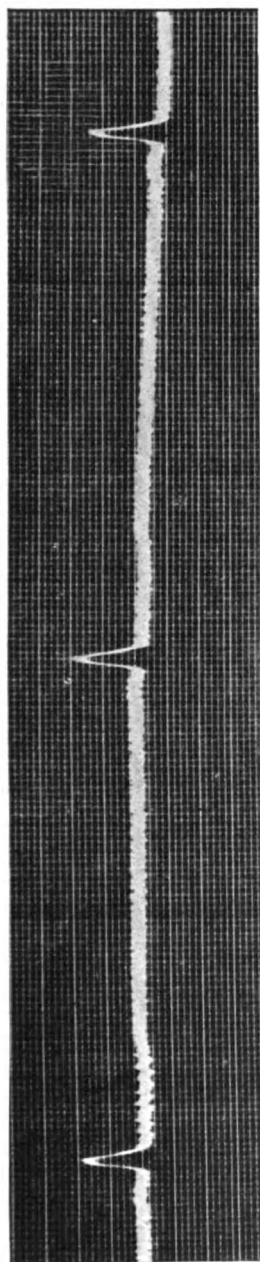
TABLE I
SEQUENCES CONTAINING NORMAL BEATS (N), AND SUPRAVENTRICULAR
BEATS (V).

Reference No. of Records.	Sequences	Correspond- ence expressed in Multiples.
1	N 15.5 N, 47 V, 16 N	3
	N 16 N, 83 V, 48 V, 16 V, 29 N	5, 3, 1
2	N 29 N, 28.5 V, 27.5 V, etc.	1
	N 26 V, 26.5 N, 26.5 V	1
	V 27.5 V, 32 N, 26.5 V	0
3	N 30.5 V, 32 V, 31.5 V, 29.5 N, 32.5 N	1
	N 38 V, 36.5 N	1
	N 34 N, 50.5 V, 28 V	0
	N 18.5 N, 41.5 V, 19 N, 15.5 N, 47.5 N, 16 N	2, 3
4	N 43.5 V, 45.5 N	1
	V 39.5 N, 44 V, 40.5 V, 44.5 V, 18 N, 47.5 V, 17.5 N, 48 N, 16 N	? 1, 3
6, 5	N 17.5 N, 30.5 V, 26 N	0
7	V 40 V, 39.5 V, 23.5 N, 39.5 V	0
8, 10	V 25.5 V, 33.5 V, 31 N, 33 N	0, 1
	N 40 V, 27.5 N, 31 N, 28.5 N	0
9	N 43 N, 50.5 V, 16 N, 48 V, 48.5 V, 15 N, 38 V, 24.5 V, 44.5 V, 17 N	3, 0, ?
11	N 53.5 N 43.5 V, 40 V, 25 N, 42 V, 54.5 V, 55.5 V, 44.5 V, 17 N	0
12	N 8.5 N, 37.5 V, 39 N	1
	N 2.5 N, 36 N, 33.5 V, 34.5 V	1
13	N 7 V, 23 N, 47.5 V	2
14	V 4 5 V, 42 V, 38 N, 20 N	2
15	V 12 N, 28 V, 26 N	1
	N 17.5 N, 115.5 N, 34.5 V, 33.5 V, 36.5 V, 20.5 N	0
16	V 46 V, 48.5 V, 49 V, 47.5 N	1
	V 51.8 V, 50.4 N, 51.8 V	1
	V 40.8 V, 21.8 N, 39.5 V, 52.6 V, 28.6 N, 15 V	2, 1
17	N 13.5 N, 27 V, 16 N, 13 N	2
	N 43 N, 106 V, 32 V, 15 N	5, 2
18	Nil.	
19	N 19.5 N, 53 V, 22 N, 16 N, 51.5 N, 60.5 V, 49 V, 45 V, 21 N, 46 V, 54 V, 39 N	0

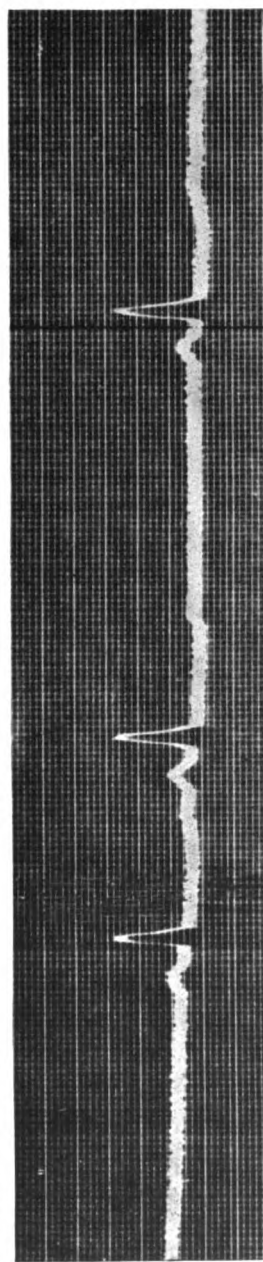
others follow intervals which are two, three and five times the length of the dominant rhythm. Sometimes the latter changes within a few beats. Thus in the fourth sequence of Record 3, the dominant rhythm is about 20 for the first three beats, for the last three it is 16.

In only eight sequences is there no simple relationship between the V's and the N's. In the twenty-one remaining sequences simple relationships exist, though sometimes in the longer ones they are not present all through the tracing. These relationships are an indication that the ventricular beats are not merely escapes, but owe their origin to the same cause as the normal beats.

Lead II.

R-R intervals in $\frac{1}{2}$ ".37 $\frac{1}{2}$

39

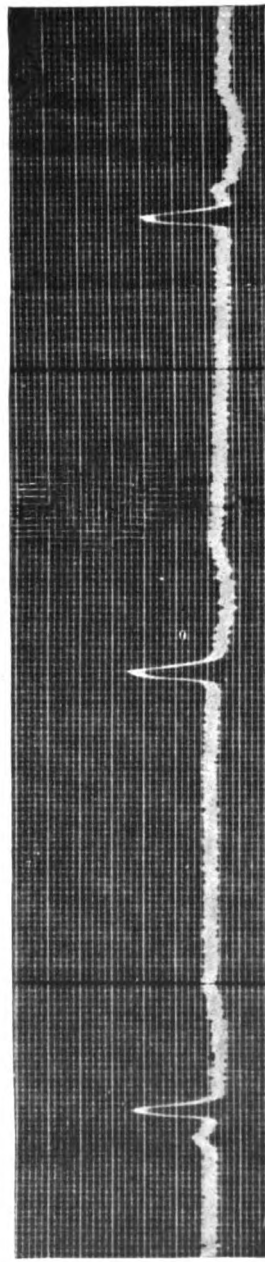


39

16

32.5

36

Time in $\frac{1}{10}$ ".

33.5

34.5

FIG. 6.

The second indication depends on the fact that in certain tracings the P waves are of varying height. This is shown well in the first five complexes of Fig. 6 (Record 12). It would be difficult to be certain of their presence at all in the first three beats, were it not for the succeeding three beats where they are very well marked. Eyster and Meek⁷ have observed a diminution in the height of P due to vagal action after morphia.

In Record 3, where simultaneous jugular tracings were taken, when the height of P was less than usual, the *a* wave was hardly visible, showing that the auricle was contracting less strongly.

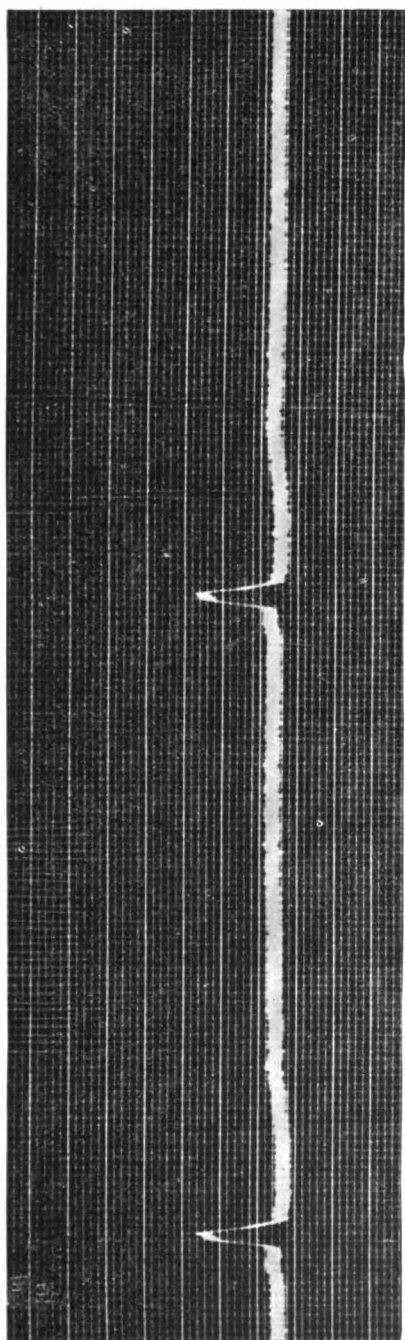
The fact that a ventricular contraction of normal size and shape may follow a weak auricular contraction is an indication that the ventricle may be stimulated independently of the auricular contraction.

A very common feature of these supraventricular contractions was that P waves often fell inside the ventricular complex. For the sake of simplicity in description this condition is called "apparent dissociation." * This is illustrated in the last complex of Fig. 6 where the P wave comes in at the bottom of the S of the complex. Sometimes it occurred later still near the T wave; at other times it appeared just in front of the R wave, so that the P-R interval was very short. This is shown in Fig. 7 (Record 7). The first P-R interval is 0.06", and the second is 0.08", and in the third, if present at all, it is 0.02", and in the fourth the P and the R waves fall together. The penultimate complex in Fig. 6 (Record 12) may also be explained by the coincidence of the P and R waves, and this is the more likely because the interval between the preceding P and the penultimate R is the same as that between this point and the ultimate P buried in the last complex. That this dissociation was apparent and not real is shown by the fact that on no occasion was there an isolated P wave in the records, which would have been bound to occur if there had been complete A-V block with the auricles and ventricles beating independently.

In many cases complexes with shortened P-R intervals were mixed up with others containing P's buried in the latter part of the complex. In Record 2 there is a whole series of beats showing "apparent dissociation," which shows points of similarity to a case published by Naish.⁸ They are represented diagrammatically in Fig. 8, which shows the ventricle being excited by the S-A node directly. The auricle is beating regularly, the intervals only varying between 28.5 and 29.5, while

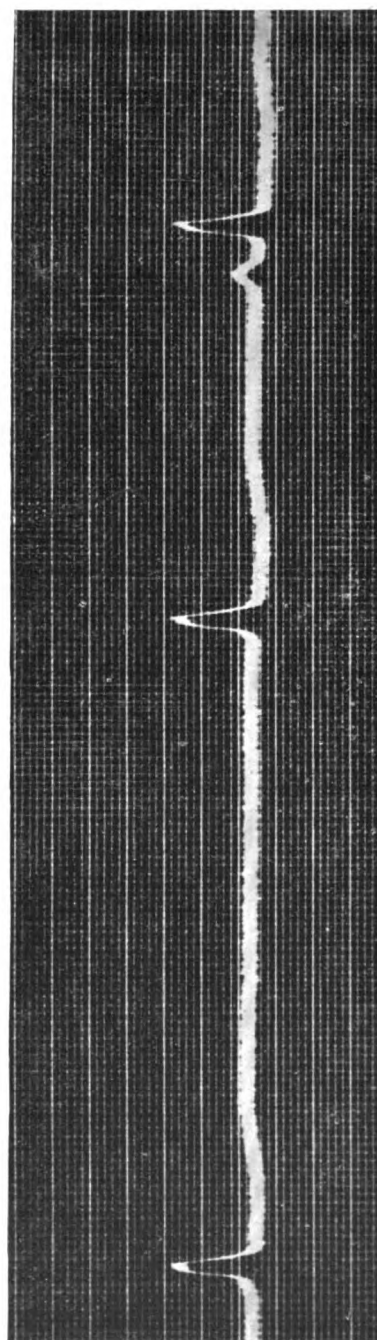
* The term "dissociation" usually means the condition where auricle and ventricle are beating independently of one another, such as occurs in complete A-V block.

Lead III.

R-R intervals in $\frac{1}{2}$ ".

39.5

40



39.5

23.5

Time in $\frac{1}{2}$ ".

FIG. 7.

the ventricular intervals vary between 26.5 and 33.5. Twice during the sequence the auricular and ventricular beats coincide. This is shown in the E.C.G. by a supraventricular complex containing no visible P wave, but from the regularity of the auricular beats it is assumed that the P and R coincide. The rest of the tracing shows ventricular complexes with P's buried in them at different points. This series can be explained as Naish has done, by the ventricular contraction receiving its impulse from the sinus independently of the auricle. The first five beats have a normal P-R interval of 0.12". In the sixth beat the P-R interval is 0.08" and in the seventh it is abolished. Then the impulse passes more quickly to the ventricle than usual. The passage becomes still quicker up to the tenth beat, where some fatigue occurs, and the ventricle falls back so as to coincide exactly with the auricle again. The same process starts again, but is suddenly stopped by a heterogenous ventricular contraction just outside the diagram, after which there is

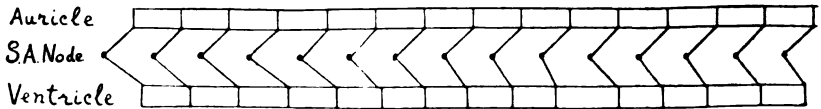


FIG. 8.

no regularity of the beat of either auricle or ventricle for some time. Owing to the uniformity of the auricular intervals it might be possible to explain this series of beats by assuming escape of the ventricles, especially as the heart rate was only 50 a minute. On the other hand it would be a remarkable coincidence for the rate of the ventricular escape to be so close to the rate of the sinus as indicated by the auricular contractions and there would be no reason for the variation in the ventricular intervals from 26.5 to 33.5.

There is one more instance in the tracings of this "apparent dissociation" when the auricular rate is more regular than the ventricular rate, but in all the other records where this apparent dissociation occurs there is no more regularity in the auricular than in the ventricular periods.

Although ventricular complexes containing buried P waves were common, it was much commoner to meet with supraventricular complexes appearing in the records irregularly containing no trace of any P. We have shown in Figs. 6 and 7 that there is some reason for assuming in special cases that the P coincided with the R and so got lost, but we cannot assume this in every case when a supraventricular complex was seen, because there

were many more of them in the tracings than would be expected from the number showing apparent dissociation.

Further, it has already been shown from the polygraph tracing (Fig. 1) that supraventricular contractions occurred with no trace of any auricular contraction, and in the other jugular pulse tracings obtained there were many instances of ventricular contractions with complete absence of *a* waves.

EFFECT OF ATROPINE AND EXERCISE

Small doses of atropine produced no perceptible effect on the heart rate. On one occasion the patient was given $\frac{1}{16}$ gr. subcutaneously every four hours for six doses. Slight quickening of the heart took place, but the irregularity was not abolished. It is possible that the injection of $\frac{1}{32}$ gr. might have caused the heart to beat regularly.

The effect of exercise was tried when the patient was lying in bed. She was asked to sit up and lie down in bed alternately a few times. The pulse became more irregular as the result. Levine tried the effect of exercise and obtained a similar effect.

Later on, when our patient was walking about preparatory to going out, the cardiac condition being the same as before, the effect of more severe exercise was tried. The surprising fact was then discovered that the heart's rate quickened and the irregularity was completely abolished. This was confirmed on several occasions with electrocardic graphic records.

On November 26, 1918, she ran up and down a flight of thirty stairs, each of them 6 in. high, six times in $1\frac{1}{2}$ minutes. This made her distinctly out of breath. The E.C.G. was started 15 seconds after cessation of the exercise. The intervals between the early heart-beats on the record were $11/25$ ths of a second, which correspond to a rate of 136 per minute. The intervals gradually increased to 18, corresponding to 83 per minute.

At this point, which was about $3\frac{1}{4}$ minutes after the exercise was finished there was a pause with complete cessation of the heart-beat for 6.6" (Fig. 9), after which the pulse suddenly became irregular. The state of affairs may be represented diagrammatically as follows, using the same notation as in Table I. Ab. V representing a heterotopic idioventricular beat.

. . . N 18 N, 16.5 V, 11.5 Ab. V, 35 V, 12 N, 28 V, ? 12 N, 16.5 V, 26 N, 11.5 N, 16 N, ? 30 V, 16 N, ? 30 N, 18.5 N, 17.5 N, 11.5 N, 34.5 V, 33.5 V, 36.5 V, 20.5 N, 11.5 N, 15 N, 16 N, 46 N, 18.5 N, 71.5 N, 26 N, 15 N, 14.5 N, 15 N, 56 Ab. V.*

* See Fig. 4, Type 1.

Lead II.

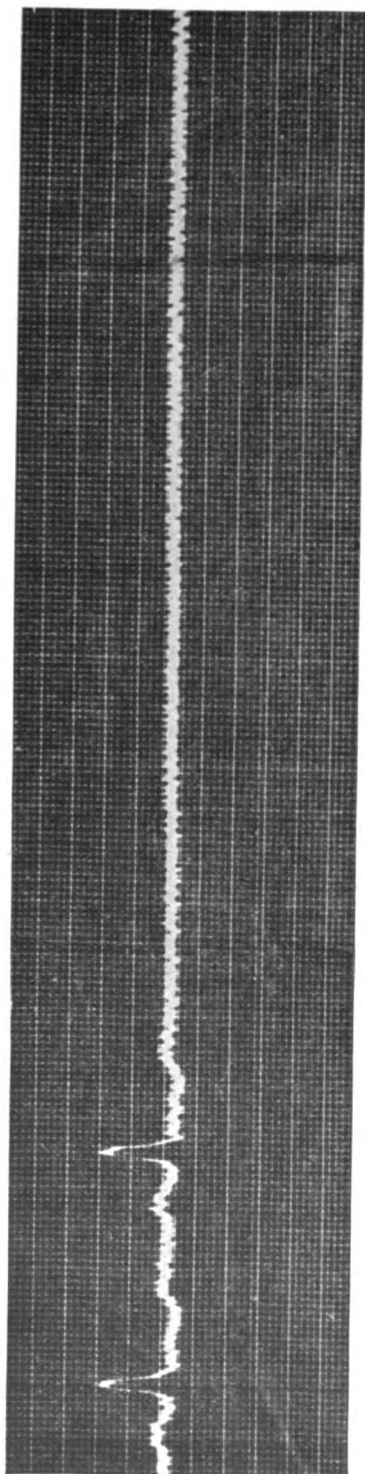
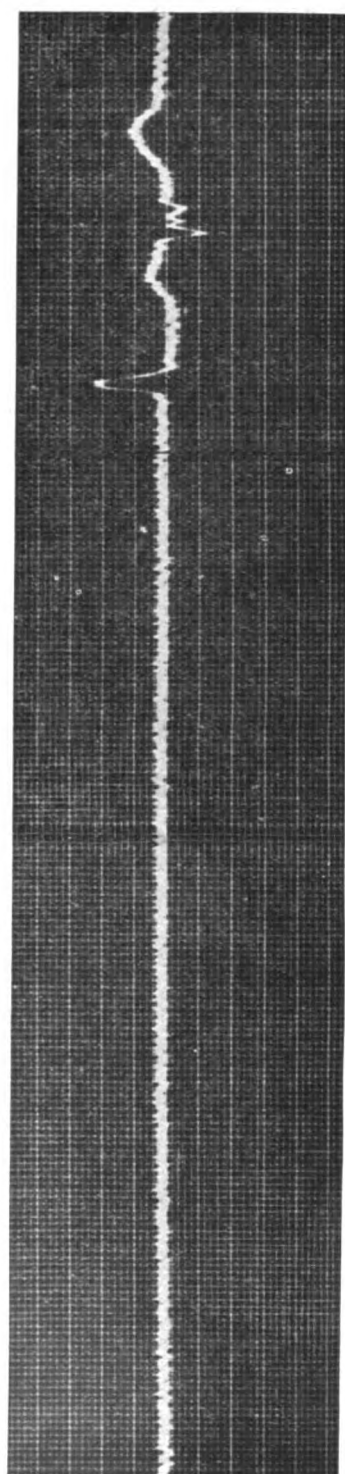
R-R intervals in $\frac{1}{2}$ ". 18Time in $\frac{1}{2}$ ".

FIG. 9.

165

Unfortunately owing to the length of the roll the tracing became a little defective at the end, and there was occasional doubt as to the lengths of the intervals.

The general nature of the irregularity is, however, perfectly clear. The sequence of normal beats is interrupted by a pause of 6.6" (165). Then follows a series of ventricular beats and later normal beats, and after fourteen beats there is the same state of affairs as just before the pause, the interval being about 18. Then there follows a second pause of 115.5 (*i. e.* 4.6 secs.) and then the pulse tends to quicken again, but this time the attempt is not so successful. After 9 beats with irregular intervals a third pause of 71.5 (*i. e.* 2.9") takes place. After this the pulse becomes much the same as it usually was during rest. This experiment shows that the cardiac irregularity cannot be due to a structural change in the heart; it argues in favour of some nervous action, possibly increased vagal tone. Exercise possibly due to metabolites poured into the circulation abolishes this influence, and the effect continues for some minutes after the exercise is stopped. The process then becomes like the swing of a pendulum, first of all in the direction of increased nervous action, producing the long pause; then the effect of the exercise reasserts itself for a few beats, to be followed by a rather shorter pause and so on.

Even during rest there is evidence of this struggle between some accelerating and some retarding influence. This is shown by the tendency for beats with short intervals to occur regularly. There is coupling and sometimes tripling of beats.

In Record 4—

N 46.5 N, 39 N, 15 N, 34.5 N, 39 N, 15 N, 34 N, 39.5 N, 15.5 N, 37 N, 42.5 N, 53.5 N, 17.5 Ab. V. Here there is coupling of beats. A short interval occurs after every two long intervals. The last Ab. V showed great A-V delay.

In Record 3—

N 40 V, 19 N, 18.5 N, 41.5 V, 19 N, 15.5 N, 47.5 V, 16 N, 16 N, 44 N. Here there is tripling of the beats.

DISCUSSION OF RESULTS

A case of sino-auricular block coming on acutely during pneumonia has been investigated and has been shown to be due to some nervous action, being completely abolished by exercise. The tracings have also shown variations in the amount of auricular contraction, and alterations in the ventricular complexes, often associated with A-V delay. All these phenomena have been described by various authors as following vagal stimulation.

The presumption is that increased vagal tone is responsible for the cardiac irregularity in the present case.

The longer intervals before normal beats can be explained by the auricle failing to respond to sinus initiation, possibly because the impulses are weak and it requires a summation of stimuli to produce contraction. Many supraventricular contractions occur in the tracings unaccompanied by any auricular contractions, and from the fact that their period is the same as the period of the normal heart-beat the conclusion has been drawn that they owe their origin to sinus initiation. This view postulates a condition which has been suggested by Eyster and Meek and Naish, that the normal heart-beat is transmitted to the ventricle independently of the auricle, so that if the auricle does not beat the ventricle still may do so. On this view the auricle and ventricle are linked to the pace-maker in parallel, and not in series, which is the general view at the present day. On this assumption it is possible to explain supraventricular contractions containing no P waves, because this means that an impulse sufficient to cause the ventricle to contract is not strong enough to affect the auricle. It also explains the cases of "apparent dissociation," because there is either delay in the auricular path, or acceleration in the ventricular path.

The objection might be raised that an impulse too weak to excite the auricle would not be able to produce a ventricular contraction considering the length of the ventricular path. However, the A-V node may act as a kind of relay station and its chief function may be to reinforce the weakest impulses that arrive from the pace-maker—impulses that may themselves be too weak to affect the auricular muscle. This will be considered later.

It is necessary to consider briefly what external evidence there is in favour of this hypothesis. There would seem to be no doubt of the fact that there is no specialised path from the sinus node to the A-V node. Naish gives the references and so they will be omitted. Eyster and Meek,⁹ however, found by placing non-polarisable electrodes on different points of the auricle that the A-V node showed electrical negativity before other parts, and concluded that it was excited very early.

Lewis, Meakins and White¹⁰ have investigated the conduction of the excitation wave of auricular contraction by means of paired contacts placed in different positions on the auricular wall and inside the auricle. This wave, called the "intrinsic disturbance," is a prominent wave of negative variation, which spreads out radially from the S-A node with the same velocity in all directions. It reaches the A-V node rather late, as the

distance between the S-A node and A-V node is relatively great. The intrinsic wave is associated with the actual contraction of the auricular muscle at the point under observation. However, at points on the auricle, except actually at the S-A node itself, this intrinsic disturbance is preceded by a smaller positive wave called the "extrinsic disturbance," and this is specially marked at the site of the A-V node. They do not agree with Eyster and Meek, that the A-V node is excited early and they criticise them for not separating intrinsic from extrinsic effects, and for the arrangement of their electrodes. Their explanation of the extrinsic disturbances is that it is due to a spread from muscle contracting between the point investigated and the S-A node. For this explanation to hold good, we must assume that the real contraction wave progresses relatively slowly, while the secondary electrical disturbances due to muscular contraction are conducted more quickly. We should like to suggest the possibility that the secondary electrical disturbances may be the normal exciter of the A-V node, which itself initiates a new impulse that passes down to the ventricle. That the extrinsic disturbance at a particular spot may be independent of the excitation wave, has been shown by Lewis, Meakins and White, since they crushed a thin ring of muscle round the base of the auricular appendix and observed that the extrinsic wave still arrived at the tip of the appendix, whereas the intrinsic disturbance was no longer observed there. This hypothesis fits in very well with our observations in the present case, because the extrinsic disturbance would provide a means for the ventricle to be excited primarily by the S-A node, when there was no complete contraction of the auricle with its associated excitation wave. In this condition the disturbance initiated at the sino-auricular node may be very weak, so that it fails to spread over the auricle, though there may be some local contraction just in the neighbourhood of the node, which will give rise to the extrinsic wave. This may be conducted over the auricle and excite the A-V node. The latter structure may contain some reinforcing mechanism, so that the weakest impulses may produce normal ventricular responses. In other cases the excitation wave may spread over the auricle, but may be so weak as only to produce a small auricular contraction.

Hitherto the sino-auricular node has been regarded as the site of origin for the beat for the *whole heart*. This spreads out over the auricle, is conducted across the A-V node, where some delay occurs, and then passes rapidly down the A-V bundle to the ventricle. The A-V node is looked upon solely as a conductor in the case of the normal heart-beat. However, its

structure is allied to that of the S-A node and so there is no difficulty in imagining that it is in reality the normal initiator of the ventricular beat, with a natural rhythm slower than that of the S-A node. In fact this hypothesis explains a difficulty with regard to nodal rhythm and complete heart-block, because if normally the node is solely a conductor why should it suddenly develop the power of initiating beats under certain pathological conditions?

Further, the action of the vagus can be readily explained along these lines. It is well known that both S-A and A-V block may follow vagal stimulation. Possibly the term A-V depression might be used in this connection leaving the term A-V block to denote interference with the A-V bundle. Similarly S-A depression might be used instead of S-A block. It is only necessary to suppose that the vagus depresses both the nodes in exactly the same way.

On this hypothesis A-V block would be of two varieties. It would be either due to the depression of the A-V node or to structural defects in the A-V bundle. The heart-block that Lewis first found in auricular fibrillation would be due to depression of the A-V node and in auricular fibrillation digitalis would act on this structure.

We do not see that this hypothesis is inconsistent with any of the well-known facts about the heart-beat.

In conclusion we would explain all the phenomena observed in this case by increased vagal tone abolished by exercise, and we suggest that in other pathological cases showing so-called S-A block sufficiently strenuous exercise, if it could have been tried, would have caused the block to disappear.

SUMMARY

(1) A case of S-A heart-block following pneumonia has been described, which has been certainly present for nearly two years. The condition was abolished by exercise, and is considered to be due to increased vagal tone.

(2) The presence of supraventricular contractions showing absence of P waves occurring at intervals similar to those of the normal heart-beats suggests that there is some direct connection between the S-A node and the ventricle, irrespective of the contracting auricle.

(3) It is suggested that the A-V node normally initiates the ventricular beat, and is excited by an extrinsic current from the S-A node which arrives in front of the auricular excitation wave.

(4) A permanent rise of 125 mm. in the systolic blood-pressure occurred within a period of less than two years.

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ACHOLURIC JAUNDICE

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DURING the latter half of the last century there were several isolated references to families, in which many members suffered from chronic jaundice or splenomegaly. In 1890 Claude Wilson¹ gave a good description of a family residing at Tunbridge Wells, with cases of jaundice and an enlarged spleen occurring in three generations. He also described the attacks of fever and biliousness from which they suffered periodically, and remarked that the attacks were very unlike malaria, although he could not think of any other diagnosis.

Eight years later Hayem² published such a clear description of five cases, that the disease was established as a clinical entity, and distinguished on the one hand from splenic anæmia and on the other hand from true jaundice. He described the four main points of the disease—the chronic icterus, the large spleen, the anæmia, and the presence of bile pigment in the serum, although it was absent from the urine. From this last feature the disease received its name of acholuric jaundice. He recognised the acute exacerbations, in which the jaundice deepened and the anæmia became more severe.

In 1900 Minkowski³ described eight cases occurring in one family. In other particulars they resembled Hayem's cases. He also observed that the urine contained an excess of urobilin. Accounts of similar families, in which the details were not so complete, were published by Collier,⁴ Bovaird,⁵ Brill,⁶ and Springthorpe and Stirling.⁷

In 1907 Chauffard⁸ found that in these cases of acholuric jaundice the red blood cells underwent hæmolysis more easily than normal red cells. This discovery invested the disease with great interest, and a large literature dealing with it has since appeared.

To estimate the fragility of the red cells, Chauffard made use of the method described by Ribière.⁹ The following slight modification, which was suggested by Mr. J. H. Ryffel, has been used for most of the determinations in this paper.

A series of test-tubes is arranged, containing 5 c.c. of different strengths of sodium chloride solution, viz. 0·66, 0·60, 0·54, 0·48, 0·45, 0·42, 0·39 and 0·36 per cent. NaCl. Into each of these 0·1 c.c. of the corpuscles of the blood to be examined is introduced. The end point is more sharply defined, and the results are more constant, if the corpuscles are washed with normal saline solution and separated by centrifugalising. The contents of the tubes are well mixed, and are left standing for two or three hours. After this the corpuscles will have settled down, and it is easy to see at what strength hæmolysis has taken place.

The results vary slightly according to the exact technique used, but are approximately constant for all normal individuals. Hæmolysis normally commences at about 0·45 per cent., and is complete at 0·36 per cent. NaCl. In a case of acholuric jaundice there is a striking contrast—hæmolysis starts at 0·66 or 0·60 per cent. NaCl, and is complete at 0·45 per cent.

There is no other disease in which there are such marked changes in the fragility of the red cells, though there are small deviations from the normal in certain conditions. Giffin,¹⁰ using the same method, found the fragility diminished in obstructive jaundice, splenic anæmia, secondary anæmias, pernicious anæmia, and after splenectomy. Bigland,¹¹ who produced hæmolysis with saponin, obtained similar results, except that there was very little, if any, change in cases of pernicious anæmia. He also found that, though the normal fragility was so constant in man, there were enormous variations in different animals.

This fact of the increased fragility of the red cells in acholuric jaundice has made it possible to distinguish the disease clearly and sharply from all other conditions.

As we have seen, two forms of the disease have been described—the familial form and the acquired form. In the large majority of cases of the familial form, the disease is also congenital. The acquired form is more severe in its onset, and the average red cell count in the published cases is about two millions. The familial form is in general less severe, and the average red count is about three millions. Apart from this there does not seem any great difference between the two groups.

The familial form must be acquired some time, and in the family described by Wilson,¹ the mother of two affected children, who transmitted the disease to some of their offspring, was herself affected comparatively late in life, and did not know of any similar cases among her relatives. Hynek has reported a similar case. From most points of view the two groups may be considered together.

The other discovery, which has added to the special interest of this disease, is that great improvement occurs after splenectomy.

Micheli¹² in 1911 reported a successful removal, and the following year Banti¹³ published an account of a patient whose spleen he had had removed in 1903. The following year Springthorpe and Stirling⁷ in Australia reported the removal of large spleens from several members of a family. Later some old successful cases were recognised, in which a diagnosis had not been made at the time of operation; thus Dawson¹⁴ reported a case in which the spleen had been removed by Spencer Wells in 1887, and Bland Sutton¹⁵ reported another upon which he had operated in 1895.

A single fatal result recorded by Vaquez in 1907, when much attention was focused on the condition, had a great influence in prejudicing against operation, but since 1911 it has become increasingly common.

After splenectomy the jaundice and anæmia rapidly improve, and there does not seem to be any tendency to recurrence. It is not yet agreed whether the fragility of the red cells returns to normal. Several cases have been reported,^{14, 16, 17, 18,} in which the fragility remained abnormal for long periods after the operation. In the majority of cases, however, the fragility returned to normal. In the case of Dr. Fawcett's, referred to later, the fragility was almost, but not quite, normal eighteen months after the operation.

The following two cases are good examples of the familial and acquired types of the disease respectively.

CASE OF FAMILIAL ACHOLURIC JAUNDICE

Nellie K. was born in 1896. As a baby she was noticed to be yellow, and throughout childhood she had "bilious attacks" with vomiting, when her colour became deeper. When twenty years old she was admitted to Guy's Hospital under Sir William Hale-White for pain in the left side and vomiting. She was in hospital three times during the year without much change. Her colour was always yellow and became deeper on three occasions, when she had attacks of vomiting and pyrexia. During one of these attacks her urine contained bile pigment and urobilin, but there was not a complete obstructive jaundice. Her spleen was much enlarged—at least six inches below the costal margin. Her liver was not felt to be enlarged. There was no ascites. Her Wassermann reaction was negative on two occasions.

Several blood counts were done with very similar results—hæmoglobin 78 per cent., red cells 4,500,000 per c.mm., colour index 0.8; white cells 13,000; polymorphonuclear 76 per cent.,

eosinophils 4 per cent., basophils 1 per cent., lymphocytes 14 per cent., hyalines 5 per cent., and myelocytes 1 per cent. Apart from the jaundice, the anæmia, and the very large spleen, her physical condition seemed normal. She was married soon after her discharge.

Two years later she was re-admitted for uterine hæmorrhage. A two months' abortion followed. Her general physical condition was the same, but her anæmia was more marked—hæmoglobin 56 per cent., and red cells 3,400,000 per c.mm. The Wassermann reaction was again negative.

Two years later (1920) she was admitted under Dr. Fawcett. Her general condition was fair, but she complained of pain in the side and fainting attacks. She was four months pregnant. Her skin and conjunctivæ were yellow, and she looked anæmic. Physical examination showed that the spleen was much enlarged—apparently the same size as in 1916. No other abnormality was detected. Mr. Maizels found that her blood count showed a much more severe anæmia than previously—hæmoglobin 38 per cent., red cells 1,800,000 per c.mm., and colour index 1.0; white cells 10,000; polymorphonuclear 72 per cent., large and small lymphocytes 24 per cent., eosinophils 1 per cent., basophils 0.5 per cent., myelocytes 2.5 per cent. Some aniso-cytosis, slight poikilocytosis and a few nucleated reds were observed.

Mr. Ryffel found that her urine contained no bile pigment, but a large amount of urobilin, and that her blood serum contained much urobilin and a trace of bile pigment. Bile was present in the fæces. The fragility of her red cells was much increased. There was partial hæmolysis with 0.66 per cent. NaCl, and hæmolysis was complete with 0.42 per cent. With a normal control there was slight hæmolysis at 0.45 per cent., and it was complete at 0.36 per cent.

She was treated with iron and arsenic, and after a short rest in hospital was discharged to the out-patient department. Two months later her anæmia was less—the hæmoglobin was 50 per cent., and the red cells 2,700,000 per c.mm. Her general condition was better, but the spleen was the same size.

Four months later she was admitted under Mr. Chapple for her confinement. Her hæmoglobin had risen to 62 per cent., and her red cells to 3,500,000 per c.mm. The fragility of the red cells was not much changed. There was partial hæmolysis with 0.6 per cent. NaCl, and it was complete with 0.45 per cent. The yellow colour was less noticeable than any time she could remember. Her general condition was much better than four months before. The enlargement of the uterus had pushed the spleen upwards and to the left. This caused a good deal of pain and was the only symptom of which she complained.

Her labour was uneventful, and the child appeared healthy. In blood taken from the umbilical cord the red cells did not show abnormal fragility. There was very slight hæmolysis at 0.45 per cent. NaCl, partial hæmolysis at 0.42 per cent., and complete hæmolysis at 0.39 per cent. Evidently the placenta acted as

an efficient barrier to the transfer of the agent responsible for the increased fragility.

This woman can be regarded as a characteristic case of the disease. It was congenital and familial. Acholuric jaundice, anæmia, splenomegaly and increased fragility of the red cells were constant features. At times there were attacks of more severe hæmolysis with shivering, vomiting and pyrexia. In the intervals between these attacks she was able to lead a normal life. She was able to bear children, and may live to old age. There was no evidence of gall-stones, though these are present in about half the cases.

The blood counts can also be regarded as characteristic. On one occasion the hæmoglobin percentage was only 38. In another member of the family, who was in good health twelve years later, it had been as low as 15. Even with these severe degrees of anæmia, there was a relatively high colour index, generally 0·8 or 0·9.

The white counts were sometimes slightly increased and sometimes slightly decreased, and taking an average they were not greatly changed. The differential count showed generally a small relative increase of polymorphonuclear cells and decrease of lymphocytes, and a small percentage of myelocytes. Poikilo- and aniso-cytosis were frequently found, and nucleated red cells were generally present when the hæmoglobin percentage was under 40.

CASE OF ACQUIRED ACHOLURIC JAUNDICE

Poppy C. was born in 1900, and had no illnesses of special interest till she was sixteen years old. There were no cases of jaundice or splenomegaly in her family.

In 1916 she had severe tonsillitis, after which her tonsils were removed. Soon after this she was again ill with a septic rash on the legs, and following this she had menorrhagia. She then had attacks of headache, vomiting, and jaundice, and her spleen was found to be much enlarged. No disease of the pelvic organs could be found to account for the hæmorrhage.

She was admitted into Guy's Hospital in 1919 under Dr. Fawcett. Her spleen was easily palpable three inches below the costal margin, and she was jaundiced. Physical examination showed no other abnormality. A blood count by Dr. Nicholson gave the following result—hæmoglobin 99 per cent., red blood cells 4,200,000 per c.mm., and colour index 1·1; white cells 9000; polymorphonuclear cells 60 per cent., eosinophils 1 per cent., basophils 0·2 per cent., lymphocytes 35 per cent., hyalines 3 per cent., myelocytes 0·2 per cent. There was moderate aniso-cytosis.

Mr. Ryffel found on several occasions that her urine contained excess of urobilin and no bile pigments, and that her serum contained a moderate amount of urobilin and a trace of bile pigments. Mr. Braithwaite found that her red cells were hæmolysed with 0·6 per cent. NaCl, while normal cells were

hæmolysed with 0·4 per cent. by the same method. Her Wassermann reaction was negative.

Splenectomy was decided on, and her spleen was removed by Sir Alfred Fripp. She made a good recovery, and her jaundice rapidly disappeared. Eighteen months later she remained in good health.

Six months after the operation her blood count was hæmoglobin 82 per cent., red blood cells 4,900,000 per c.mm., colour index 0·85, and white cells 26,000 per c.mm. A year later it was hæmoglobin 90 per cent., red blood cells 4,700,000 per c.mm., and colour index 0·96. Her red cells were hæmolysed with 0·48 per cent. NaCl, which was a great improvement compared with before the operation, but not a complete return to normal.

A section of the spleen after removal showed congestion and a very slight increase of fibrosis.

This patient was unusual in showing no anæmia in spite of the menorrhagia and hæmolysis. In other respects it was a well marked case of acholuric jaundice.

AN ACHOLURIC JAUNDICE FAMILY

The first of these two cases belonged to a family in which several members suffered from acholuric jaundice. As not many families have yet been reported in detail, it may be interesting to give full particulars of this one.

The family illness dates back to the grandmother of most of the cases. All that is known about her is that she was yellow coloured for many years before her death.

Of her five children, four were normal. The fifth, a girl, was in the London Hospital in 1897, when she was twenty-six years old. She was admitted for shortness of breath, abdominal pain and anæmia. She was sallow coloured and had been so for some years. Her spleen reached below the umbilicus. Her blood count was as follows—hæmoglobin 35 per cent., red cells 2,000,000 per c.mm., white cells 70,000 per c.mm. Her heart had a presystolic murmur. No change in her condition followed treatment with iron and arsenic. She died seven years later at home, and there was no post-mortem examination. The diagnosis made at the time was leukæmia. There was no differential count, and the white cells were only counted once. In view of the long history, the large spleen, the sallow colour and the anæmia, it seems possible that this was a case of acholuric jaundice, occurring many years before the disease was accurately described.

Of the four normal children of the second generation, the eldest son married a normal woman, and they had twelve children.

The eldest has always been healthy. Her spleen has not been enlarged and she has not been anæmic. She has five children, of whom three are healthy and two have died—one of pneumonia and one of some unknown cause.

The second was said to have had good health until he was twenty, or at any rate he was free from attacks of jaundice. He was then admitted to the Seaman's Hospital at Greenwich, and after a long illness, complicated with empyema and jaundice, he died. Post-mortem stenosis of the mitral valve was found, and there were calcareous nodules in the cusps. The liver was much enlarged and showed multi-lobular cirrhosis. The spleen was not mentioned, so was probably normal. In the absence of splenomegaly and a long history of jaundice, it seems unlikely that he suffered from the family disease. His mother distinguished quite clearly in her own mind between the jaundice from which he had suffered and the jaundice of two of her other children.

The third child had always good health till he went to India as a soldier, where he was reported dangerously ill with malaria.

The fourth, Nellie K., has been fully described above.

The fifth was healthy and had two healthy children.

The sixth and eighth were examined and seemed in perfect health.

The seventh was often ailing, looked anæmic, and had a spleen palpable about two inches below the costal margin. He had never been yellow and unfortunately a blood examination was refused.

The ninth—Albert, aged twelve—was jaundiced at birth. This cleared up after a month, but he had always been slightly yellow, and had been liable to attacks of shivering and vomiting, when he became a deeper yellow. He was admitted under Dr. Fawcett after one of these attacks. He was a yellow colour, and appeared slightly built. His spleen was palpable about four inches below the costal margin. The liver was not felt to be enlarged. There was no ascites. His heart was slightly enlarged and there was a systolic bruit. His urine was normal. His serum contained much urobilin and a trace of bile pigment. His blood count was—hæmoglobin 69 per cent., red cells 4,800,000 per c.mm., colour index 0.75. His red cells showed partial hæmolysis with 0.66 per cent. NaCl, and complete hæmolysis with 0.45 per cent.; while with normal cells it was slight with 0.45 per cent., and complete with 0.39 per cent. NaCl. His Wassermann reaction was negative.

The tenth child died before he was a year old with diarrhœa.

The eleventh and twelfth appeared quite healthy and the blood of both showed normal hæmolysis.

There were three other normal children of the second generation. One had one normal son. One had three daughters and four sons, all healthy, except one who had chorea and mitral stenosis. The third, a daughter, had eight children of whom four were affected.

The eldest was treated for anæmia before he was a year old. When five years old he was still anæmic, and had a large spleen. The second died in infancy. The third was said to be normal.

The fourth suffered from acholuric jaundice and resembled very closely her cousin Nellie, whose case has been described. In 1909, when fourteen years old, she was admitted to the London Hospital with headaches, vomiting, shivering and abdominal pain. Her spleen was enlarged three inches below the costal margin. She was anæmic and yellow in colour. For seven days her temperature was 100–101°. She had been of an unusual colour for some years, with exacerbations in which she became definitely yellow. She was discharged after three weeks. Two years later she was readmitted. Her anæmia was less, but her spleen was now palpable below the umbilicus. A hæmic bruit was present, and there was œdema of the legs. Twice during her stay in hospital she developed moderately severe attacks of purpura. Bile pigment was present in her serum, but not in the urine. The fragility of her red blood corpuscles was increased. Three years later, in 1914, she was again admitted. Her physical condition was similar, and previous findings were again confirmed. When seen seven years later, she appeared a young woman of average good health, and was pale but not yellow. She had two healthy children aged two and four. Since 1914 she had been able to do ordinary household work, but had often been under treatment for anæmia, and often became yellow. In 1909 her hæmoglobin was 15 per cent., and her red cells 1,400,000 per c.mm. In 1911 her hæmoglobin was 65 per cent., and her red cells 3,700,000. In 1914 her hæmoglobin was 35 per cent., and her red cells 2,300,000. Her white cells varied between 5000 and 12,000 per c.mm., and the differential count was similar to those already given. There was moderate poikilo- and aniso-cytosis, and when her anæmia was most severe megaloblasts and nucleated red cells were found. Her red cells were hæmolysed with 0·5 per cent., and partially with 0·6 per cent. NaCl. Her Wassermann reaction was negative on three occasions. She was under the care of Dr. Robert Hutchison,

to whom I am indebted for permission to include these investigations.

The fifth died in infancy of diphtheria. He had always been sallow, but other details are unknown.

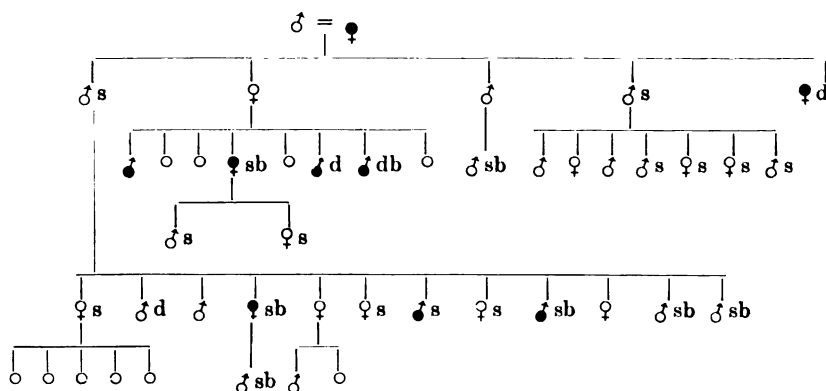
The sixth was yellow at birth, and remained so for a year until his death. Post-mortem the spleen was enormously enlarged, and there were no other abnormal findings.

The seventh was always sallow coloured, and suffered with anæmia and a large spleen. When fifteen months old he was in the London Hospital. His spleen was much enlarged; his hæmoglobin was 45 per cent., his red cells 1·5,000,000 per c.mm., and his white cells 25,000 per c.mm. Poikilocytosis and nucleated red corpuscles were present. He died three weeks later, but there was no post-mortem.

The eighth child was said to be healthy.

A family tree is given in Table I. Taking the family as a whole, there were thirty members who were probably normal, and nine who probably suffered from acholuric jaundice. In three of these the diagnosis was proved. In four, there was strong evidence of the disease. In two, the diagnosis was frankly uncertain, owing to the lack of information about the grandmother and the aunt, who had been dead many years.

TABLE I.



○ Normal males or females.

● Acholuric jaundice.

♂ Normal males.

♀ Normal females.

s Indicates those who have been seen and examined.

d Indicates those who died, and for whom hospital reports were available.

b Blood examined for hæmolysis.

INHERITANCE OF ACHOLURIC JAUNDICE

In the families I have been able to collect from the literature, where the diagnosis was sufficiently certain, there were

fifty-three members affected out of a total number of one hundred and sixty-three.

Twenty-five of these were females and twenty-eight were males—almost equal numbers.

In some cases the disease was transmitted through healthy parents, and in some cases through parents who were themselves affected. These facts make it difficult to understand the inheritance of acholuric jaundice on simple Mendelian lines. If the condition was "dominant," like many other abnormalities, it should never be transmitted by healthy parents. If the condition was "recessive," as is albinism, it should only occur when both parents come of affected stock. This requisite is not likely to be fulfilled by several marriages in one family with a condition as rare as acholuric jaundice.

In the family here described no cases have yet appeared in the fourth generation. Elliott²² has reported cases in the fourth generation, but in many families there appears to be a tendency for the disease to die out.

Generally the condition is either definitely present with well marked signs, or definitely absent; but Biffis²³ has reported a family, which showed in the fourth generation five cases, in which some of the signs were present and others were absent.

If Biffis' observation should be confirmed, and if there really is a tendency for the disease to die out in the fourth generation, it cannot be a real hereditary abnormality, and it is possible that it represents some attenuated infection, which can be transmitted for some generations. At present most of the evidence is against this view. Naturally it has been suggested that the disease is a form of congenital syphilis. There is, however, remarkable agreement among all observers that the Wassermann reaction is regularly found to be negative.

PATHOGENESIS OF ACHOLURIC JAUNDICE

Apart from the inheritance of the disease there are other interesting points, which throw light on the pathology. Two theories have been put forward to account for the disease—that there is a primary deficiency in the red corpuscles, which makes them abnormally fragile, or that the spleen is primarily at fault in destroying the corpuscles too readily. The fact that the washed corpuscles show abnormal fragility is evidence in favour of the former view. The good result of splenectomy favours the latter. If it were certain that the corpuscles ceased to be hæmolyzed so readily after splenectomy, this question could be decided, but the evidence is still conflicting.

The most likely view seems to be as follows : Either from inheritance, or from some infection, the red corpuscles become abnormally fragile. Under these conditions they are hæmolyzed by the spleen in unusual numbers, and the spleen hypertrophies on account of its increased work. In this way the anæmia and acholuric jaundice are produced. After splenectomy, the red cells cannot be hæmolyzed in large numbers, and both these conditions improve.

One would naturally expect on this view that the corpuscles would still remain abnormally fragile, but it is easy to imagine that there might be some improvement even in this, because when the hæmolysis and anæmia were less, there would be less call to produce immature red cells, which might show the abnormality in the most marked degree.

In a large proportion of cases coming to operation, gall-stones have been found to be present in the gall-bladder. But it is only in a much smaller number of cases that there is any history of symptoms of gall-stones or of any disorder of the gall-bladder. In a few cases there have been definite attacks of gall-stone colic and true obstructive jaundice, alternating with the attacks of acholuric jaundice without colic, and the patients have themselves learnt to distinguish the two varieties of attacks quite clearly.

This and other reasons make it certain that the gall-stones are in some way secondary to the excessive hæmolysis and repeated attacks of jaundice, and not in any way the primary cause of the condition.

There are three questions of interest awaiting solution. Does the abnormal fragility remain after splenectomy? Is there any real justification for separating the congenital familial and the acquired forms? Is the disease an attenuated infection with a tendency to die out, or is it a real pathological variety transmitted according to the laws of heredity?

Practically the great interest of the disease lies in the very constant clinical picture, in the definite laboratory test provided by the increased fragility of the red cells, and in the striking results of splenectomy.

I wish to thank Dr. Fawcett for his help, and for allowing me to describe the patients who were under his care.

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STUDIES IN GASTRIC SECRETION

V. A STUDY OF NORMAL GASTRIC FUNCTION BASED ON THE INVESTIGATION OF ONE HUNDRED HEALTHY MEN BY MEANS OF THE FRACTIONAL METHOD OF GASTRIC ANALYSIS

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PART I

A. INTRODUCTION

IN 1914 M. E. Rehfuß¹ published his description of a modification of the Einhorn duodenal tube, and in a later article² gave an account of the curves of gastric acidity obtained in normal and pathological states by means of the fractional method of gastric analysis.

A voluminous literature has since appeared, chiefly in the American medical press, dealing with this subject, and many workers in England and America have adopted the method as an aid to clinical diagnosis; the present writers have now employed it extensively for nearly two years, and several studies have appeared in the previous numbers of these Reports.

In reviewing the American literature we were immediately impressed by the paucity of results obtained from normal persons. Rehfuß, Bergeim and Hawk² in their original paper describe certain results obtained from healthy medical students, but no mention is made of the number of subjects taking part in the tests beyond the statement that the whole inquiry into both physiological and pathological conditions included over a hundred cases. As cases were reported of gastritis, ulcer of the stomach and of the duodenum, cholelithiasis, achylia gastrica, and carcinoma both proved and suspected, it is evident that the total number of normal subjects must have been considerably lower than a hundred. The Ewald meal, consisting

* The expenditure incurred by one of us (T. I. B.) in connection with this Research has been partly defrayed by a Government Grant, on the recommendation of the Royal Society.

of ten ounces of tea and two pieces of toast was employed, the tube was swallowed immediately after the meal, and specimens were subsequently withdrawn in the usual manner, and the titrations for the estimation of free HCl and the total acidity were performed on 1 c.c. of the filtered material. The American writers summarise their findings as follows :—

“ There is no specific curve for the normal person, but three types of curve can be found depending on the rapidity of reaction to a given stimulus, the height of the curve, and the descent of the curve.

“ These types may be termed respectively the hypersecretory, hyposecretory, and isosecretory types, depending on their respective reaction to such stimuli.

“ Figures approximating those commonly regarded as hyperacidity are to be found in some period of the curve in a large number of normal persons. A ‘ continued ’ secretion is described in normal persons which is intimately linked with alimentary and chronic hypersecretion but can be distinguished from them.”

The curves illustrating these three types show—

- (1) As regards the “ isosecretory ” type, an increase of free HCl from 5 steadily up to 40 per cent. $\frac{N}{10}$ NaOH at the end of one hour, with a subsequent steady fall to the original level, the whole phenomenon occupying about two hours.
- (2) The hypersecretory type show a rapid rise of HCl to 70 or more, which high point is maintained with little if any decline; “ the food left the stomach in normal time from two to two and a half hours, but even after the passage of all food material there was often encountered an outpouring of pure gastric juice.” The curve of total acidity runs a parallel course, again at about 10 c.c. above the free HCl.
- (3) The hyposecretory type of curve is described as similar to the isosecretory, but with a slower ascent, and a high point from 40 to 50; the present writers have indeed never been able to distinguish any sufficient difference between the isosecretory and hyposecretory curves as described to warrant their being placed in different categories.

In a later section of their article, Rehfuess, Bergeim and Hawk state : “ It will be noted, and a study of cases which have not been reported seems to demonstrate, that while normally there are marked variations in acidity, there is little variation in the

motor power in health. Even high acidity may occur without any depreciation in motor tone. These facts are of the greatest importance and contrast strongly with the findings in disease." To this opinion concerning the normal motor activity of the healthy stomach we shall refer later.

We have quoted from this early article at some length because these are the results which appear to have been constantly accepted as giving a picture of the response of the normal physiological stomach when tested by fractional gastric analysis. Again and again in the American literature this early article is referred to, and though Reh fuss and his co-workers have more recently carried out innumerable tests as to the gastric response of normal individuals to foods of varying composition, we have been unable to find reference to any really extensive series of normal persons examined with a fixed test-meal and throughout the whole of the gastric digestive cycle. In November 1918³ we find Reh fuss again stating that normal subjects fall always into one of his three categories; "further study of healthy persons," he says, "only emphasises the necessity for retaining these types."

In 1915 Fowler, Reh fuss and Hawk⁴ published the result of an investigation into the gastric residuum, or resting-juice, found in over a hundred normal students; the results of this very complete investigation are confirmed by a later research by Fowler and Zentmire,⁵ who studied the resting-juice from eighty normal women, obtaining results in all ways similar to those found in the earlier work.

The present writers' inquiry into this branch of the subject further confirms these findings, to which fuller reference will be made in the section dealing with the resting-juice.

The most important contribution to the American literature dealing with gastric analysis, subsequent to the earlier articles by Reh fuss and his colleagues, is that of Crohn and Reiss; these workers published in 1917 a study⁶ of the subject based on more than two hundred curves from patients in the Mount Sinai Hospital, New York. They accept the standard curves of Reh fuss as being the true picture of the normal, and state that they found many illustrations of these types amongst a group of fifty cases which were free from organic disease; it is of interest to note that they state "the hyposecretory type was essentially the same as the isosecretory." As none of their subjects were altogether without symptoms, it is, as they themselves point out, impossible to accept their findings as an accurate index of the normal. Prior to this, Talbot⁷ had published an analysis of a hundred and fifty cases studied by the fractional method, but

of these only twenty-four were normal; his results in the main agree with Rehfuess, though he states, "In not a single instance did we record the early steep rise of acid characterised by Rehfuess as the hypersecretory type of normal curve"; on the other hand he does record one normal case where the free HCl exceeded 100 per cent $\frac{N}{10}$ NaOH.

Such is the information we have been able to gather concerning the normal gastric cycle in health after a very careful study of the American medical literature; one portion of the cycle, and one only, appears to have been thoroughly studied, and that is the resting-juice or residuum found in the stomach before the first meal of the morning. It was therefore clear to us that a full series of normals must be examined before any clear deductions could be drawn from curves obtained in diseased states, and we are now able to publish the results obtained from the examination of a hundred healthy students. Preliminary reference to this work has been made by us individually in previous communications,^{8, 9} but the full series is now published for the first time. It was at one time hoped to publish in the same article the results of x-ray examination of the same cases; many of them have been so examined for us by Dr. P. J. Briggs, but technical difficulties have made it impossible to complete this side of the investigation at present, and the demand for the normal acidity curves has been so great that we have felt it unwise further to delay publication. We are indebted to Dr. Briggs for permission to state here that all his findings as to the rate of emptying, made by x-ray observation of an opaque meal, confirm our own observations made by means of the gastric tube. Further confirmation of our findings has recently been provided by the work of E. S. Dodds, of the Biochemical Department of the Middlesex Hospital. Dodds has drawn attention¹⁰ to the rise of alveolar CO₂ tension which follows the ingestion of a meal, and he has since then made an independent examination of many of our normal subjects; in each case his examination confirmed our own findings. The results may be found in a paper published with one of us (T. I. B.) in the *British Journal of Experimental Pathology*, April 1921.

B. THE METHOD

1. *Selection of Subjects.*

By preliminary lectures and demonstrations on the technique of swallowing the tube and on the scope and purpose of the

investigations large numbers of willing volunteers were obtained from amongst the students working in the Department of Physiology at Guy's Hospital and later also at the Middlesex Hospital.

Only those are included in the present series who gave no history of grave dyspeptic symptoms, appendicitis, chronic constipation or dysentery, and who were in good health at the time of examination. A few had to be excluded on account of excessive salivation during the test or other factors which might have created a fallacy in the readings.

Notes were entered relating to their age, height, weight, complexion and family history of dyspepsia; occasional comments were also made on the ease or difficulty experienced in the swallowing of the tube and on any subjective manifestations described during the period of the test.

Without this cheerful co-operation of well over one hundred volunteers we are convinced that our work would have been impossible to conduct, and we feel that we cannot reiterate too frequently our indebtedness to those students of the two Schools who for the sake of medical research so cordially aided us.

Some of our findings are such that, had even slight symptoms been present, a clinician would have suspected the presence of a pathological condition; to define the precise meaning of the term "healthy," or "normal," is not a task which we propose to attempt now; to-day, barely two years after the cessation of the great war, it would be difficult to affirm that even a moderate proportion of the manhood of the country is mentally and physically in a perfect state. Amongst our subjects are many ex-service men, who have served in the Navy, the Army, or the Air Force; they include men who have commanded fighting battalions, four air-pilots, and the commander of a submarine. We consider them "normal" in that they have no symptoms of disease, they have no history of grave disease or injury, and they are men who now work hard and play hard, with the same energy with which they previously defended their country.

2. Time and Conditions of Experiment.

The test-meals were all started between 9.30 a.m. and 10 a.m. The volunteers received instructions to take no food or drink after 10 p.m. on the previous night. The majority of them lived at some distance from the hospital.

Smoking was permitted during the period of the test, but very seldom indulged in.

So far as possible batches of four or five friends were examined on the same day, and the writers are of opinion that the spirit

of friendly and amused rivalry so engendered contributed largely to the success of the experiments and helped to eliminate the discomforts and tedium attendant upon them.

During the tests the subjects were sitting or standing and variously occupied with books or newspapers, the general conditions being made to correspond as closely as possible to those under which a pathological case is examined.

3. *Choice of Test-meal.*

The test-meal employed throughout was prepared in accordance with a recipe employed by Crohn and Reiss⁶ and originally described by Boas. It consists of two tablespoonfuls of breakfast oatmeal stirred into one quart of water and boiled slowly down to one pint. The resulting gruel is strained through muslin, a little salt is added to taste, and the meal taken warm. The gruel should be of such a consistency as to pour with moderate ease. The advantages of the preparation are that it is of a fairly constant composition and consistency, that it contains no particles likely to block the tube, that it can be comfortably swallowed with the tube in position, and that its sojourn in the stomach is not unduly prolonged. Further, its whitish colour does not interfere with the "end-points" in the course of titration. Such requirements do not obtain so satisfactorily in the case of a mixed meal. In the case of tea and toast, for instance, there is much greater scope for variations, while meals of high protein content upset the parallelism of the curves of free and total acidity, and complicate the interpretation of the results. Ewald's test-meal may give slightly higher figures, but whether this is dependent on the psychic factor we are not able to say.

Various criticisms of the oatmeal-gruel test-meal have been made. It is suggested that, being unpalatable, it must tend to eliminate the psychic flow.

It is admitted that the meal is dull, but it is not unpleasant. It is cheap and is easily prepared, and on the whole the advantages enumerated above would seem to outweigh the disadvantages, the ease of standardisation being a particularly important feature.

4. *The Modified Tube.*

During the earlier months of the investigation an Einhorn's duodenal tube was employed. Latterly a modification planned by one of us (J. A. R.) has been in constant use and has been in several respects more satisfactory. Its structure has been described elsewhere,¹¹ but may be briefly recounted hereunder.

It consists of a rubber-catheter tubing, equal in calibre to a No. 6 or 7 soft catheter, and having a thick wall and a blind lower extremity, into which is inserted a small oval weight of lead. Immediately above the weight four holes are punched in the rubber. The tube is marked at intervals corresponding with the distance from the teeth to the cardia, the fundus and the pylorus respectively.

Its advantages are enhanced ease in swallowing and withdrawal, the avoidance of blockage by mucus of the small orifices (since the elasticity of the tube allows of easy expulsion of any particles which may accumulate there), and the diminished likelihood of slight trauma to the gastric mucosa. Further, the end of the tube cannot become detached, and its manufacture is simpler and less expensive.

5 Swallowing the Tube.

Other writers dealing with fractional gastric analysis have often laid stress on the facility with which the tube is swallowed. With this we cannot wholly agree. Much depends on the personality both of the experimenter and the subject, and encouragement and reassurance are usually necessary.

We have ourselves only failed in getting subjects to swallow the tube on four occasions in several hundred cases, so that the obstacles—which are almost wholly psychological—are not serious though commonly encountered. The difficulty is perhaps greater in dealing with the healthy man than with one who has suffered sufficient pain to compel him to seek medical advice; but the important fact to remember is that the pharyngeal spasm and retching which sometimes interfere with swallowing are to a very large degree under voluntary control. Time after time we have seen a subject have considerable difficulty in swallowing the tube the first time, and yet, having once succeeded, he has been able to repeat the performance on subsequent occasions without the slightest trouble.

The instructions which we have been accustomed to give both volunteers and patients have been somewhat as follows. The subject is requested to take the tube himself between finger and thumb at a point about four inches above the bulb, and then, with head half tilted back, to drop the bulb to the back of the tongue and swallow, not forgetting (as he often does) to “pay out” the tube simultaneously. Once the bulb is gripped by the œsophagus the head can be brought forward to the normal position. He should swallow, without haste or anxiety, at intervals of from six to ten seconds, breathing deeply and quietly through the nose all the while. He is told if he

feels any inclination to retch to close the lips on the tube and draw three very deep breaths through the nose and then to swallow again; this usually has the effect of abolishing the unpleasant reflex.

Encouragement and congratulation play their part, and the operator may occasionally have to demonstrate the swallowing of the tube in person.

Once the bulb is safely past the constriction corresponding with the level of the cricoid, the tube is propelled downwards by œsophageal peristalsis, and little voluntary effort, other than "paying out" the tube by hand, is necessary. The tube should be swallowed until the fundus mark lies just within the teeth.

6. *Withdrawal of Specimens.*

With the tube in position the whole of the resting-juice is withdrawn by gentle suction with a 20 c.c. Record syringe. The amount withdrawn is noted; if, in the middle of withdrawal, bile appears, the bile-stained and non-bile-stained portions should, strictly speaking, be separately measured, as there is no little likelihood that the second sample represents artificial reflux from the duodenum due to suction. In any case a bile-stained specimen obviously cannot be regarded as purely gastric secretion.

The gruel is then swallowed at a comfortable rate, the tube being held to the corner of the mouth.

Thereafter at intervals of fifteen minutes 10 c.c. samples are withdrawn and collected into a row of test-tubes.

A hint of approaching emptying is given by the withdrawal of frothy or bile-stained specimens of small bulk, and emptying is judged to be complete when no more can be obtained even on lowering or partial withdrawal of the tube.

Strong suction should never be exerted in the terminal stages of the test.

7. *Analysis of Samples and Estimation of Emptying Rate.*

Naked-eye observations of the amount of mucus and bile in the resting-juice and subsequent specimens are made. The free and total acidity in each specimen is estimated by titrating 5 c.c. with $\frac{N}{10}$ NaOH, using, firstly, dimethyl-amido-azo-benzol and, secondly, phenolphthalein as the indicators. The whole specimen and not a filtrate is employed.

The time of the actual emptying of the meal is determined by the addition of iodine to the residue in the test-tubes. Gruel

is sometimes found to have disappeared before the stomach is completely empty; just as the stomach before the meal contains juice, so does a certain amount of secretion continue after the meal has passed on. It has been our custom to withdraw specimens of this clear or bile-stained juice up to two and a half hours if still present, and latterly we have at that point withdrawn all the gastric contents with a view to obtaining information as to the quantity of this post-prandial secretion.

C. CERTAIN SOURCES OF EXPERIMENTAL ERROR

(1) *The Action of the Tube as a Foreign Body in the Stomach.*—

This, the first criticism levelled at the method by those

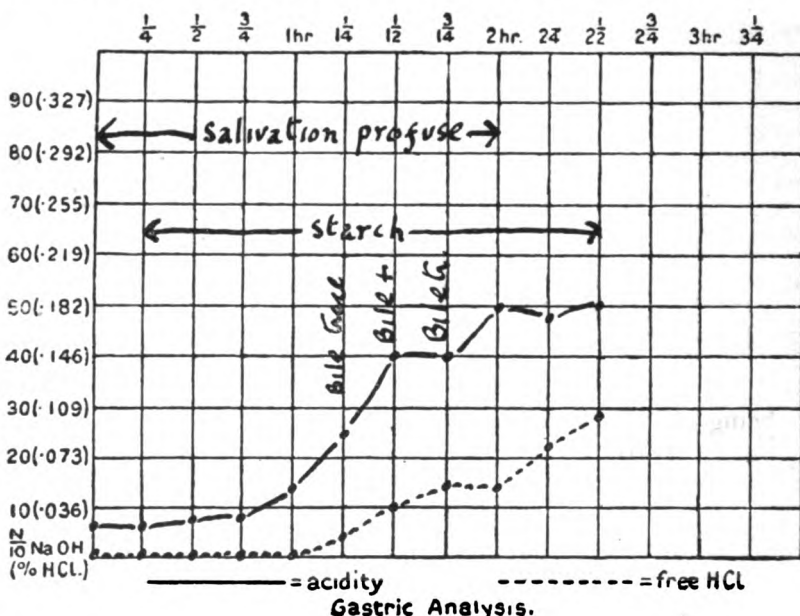


CHART I.

To show hypoacidity due to excessive salivation.

unacquainted with it, is in our opinion unimportant. We owe to Pawlow¹² our knowledge of the fact that gastric secretion cannot be secured by purely mechanical stimulation. On the other hand, Roger¹³ has shown that mechanical stimulation of the œsophagus will lead to a copious flow of saliva, this being a protective mechanism to induce the liberation of any foreign body stuck in the gullet. Any error due to this mechanical action of the tube will, we believe, be due to the factor next discussed.

(2) *Excessive Salivation.*—Cases do occasionally arise in

which the subject at first notices excessive salivation; they are rare, but it is to be expected that in such cases there will be an artificial lowering of acidity at the beginning of the chart. Such a case is illustrated in Chart I. We have excluded all such from our series.

(3) *Diminution of Psychic Secretion.*—This factor has been quoted in criticism of the gruel-meal. We are of opinion that in man the psychic secretion is much less important than in the carnivora. Support of this view will be found in Carlson's recent work ¹⁴ on hunger in health and disease.

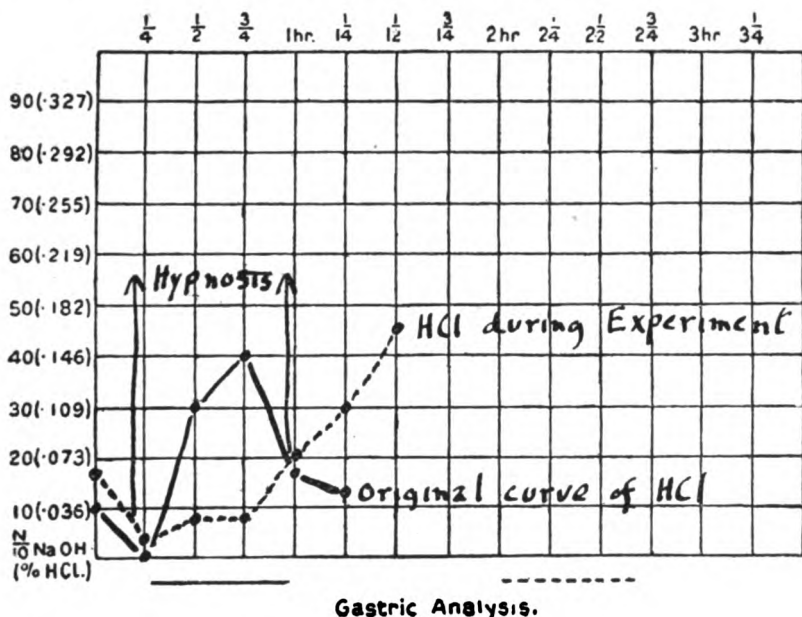


CHART II.

To show inhibition of secretion of HCl due to suggested nausea. The continuous line shows the curve of HCl in this subject under normal conditions; the broken line shows his curve of HCl when nausea had been suggested to him under hypnosis which was induced in the period indicated by the arrows.

We have on several occasions exhibited tempting food to subjects during the course of a control gastric test; hitherto we have not been able to influence their curve of acidity by this means.

(4) *Emotional Inhibition of Gastric Secretion.*—In a previous communication ¹⁵ one of us (T. I. B.), working in conjunction with J. F. Venables, has demonstrated the striking effects produced on gastric acidity by suggestions such as nausea and anxiety. An example, taken from this work, is shown in Chart II.

In very sensitive subjects such emotional inhibition may certainly produce an effect, especially during the first test. It becomes the more important that the experimenter should possess the experience necessary to restrain such emotions. This can, we believe, be readily acquired. Our subjects have been willing and intelligent volunteers, and the experiments quoted below, in section 6, lead us to think that no correction need be made in our findings for emotional disturbance.

(5) *Duodenal Regurgitation from Retching*.—Excessive retching may lead to relaxation of the pylorus with duodenal regurgitation; large quantities of bile have occasionally been found in subjects who have had great difficulty in swallowing the tube; such cases we have excluded. With careful technique they are very rare.

(6) *Variation from Day to Day in the Curve of a Given Subject*.—We have carried out a considerable number of controls to ascertain the extent of this variation. No experiment can better demonstrate the value of the fractional method; in several instances exactly identical curves have been obtained when taken on different occasions; in general, it has been found that slight differences may be found towards the end of the curve, corresponding with the amount of duodenal regurgitation at a particular moment, this regurgitation, due to the tonus of the pylorus, which changes momentarily, must evidently be a variable factor from day to day, and from meal to meal.

(7) *Loculation of the Stomach*.—In a stomach exhibiting strong peristalsis a certain amount of loculation occurs; in this way a syringe full of bile-stained contents sometimes can be withdrawn immediately after a clear sample. Attention to this factor was called in a series of experiments on hunger.¹⁵ Errors due to this source can be excluded by withdrawing the tube a few inches and then re-swallowing.

Considering these possible sources of error as a whole, it may be said that whilst some of them, especially those discussed under 4 and 5, may have some importance in modifying the curve of each subject, and may possibly tend to distort the first, rather than any subsequent curve obtained from a given subject, yet we have not found a total variation of more than about 5 per cent. of $\frac{N}{10}\text{NaOH}$ in the reading at a given moment in controlled cases.

Moreover we have deliberately chosen to secure our statistics from subjects swallowing the tube for the first time, because these are the conditions under which pathological cases must be

studied, and it is primarily with a view to its clinical application that our whole investigation has been carried out.

We have, however, rejected all cases in which we feel that a considerable error may have arisen from any of the causes discussed above.

D. THE FACTORS PRODUCING THE CURVE OF GASTRIC ACIDITY

The percentage of acid in the gastric contents at any particular moment is the resultant of several varying factors.

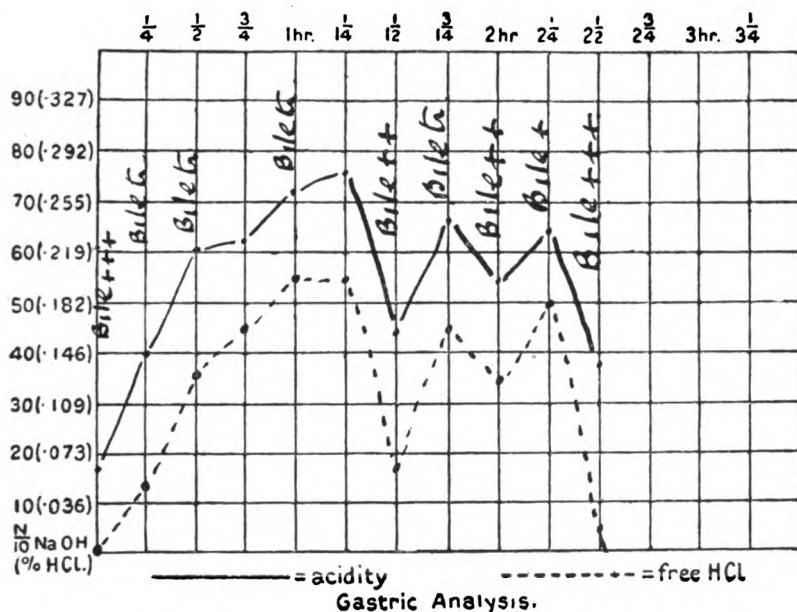


CHART III.

To show distortion of curve with lowering of acidity due to regurgitation of bile.

Of the factors producing acidity, the hydrochloric acid, secreted by the oxyntic cells, is by far the most important, and metaprotein, lactic and fatty acids, and even carbon dioxide, will all give acid reactions which affect the total acidity, but they are, in physiological cases, of minor importance.

There are, on the other hand, three distinct sources of alkali :

(a) *Saliva*, which may, if in excess, cause a considerable lowering of acidity, both by its diluting action as well as by virtue of its reaction.

(b) *Regurgitation of Duodenal Contents*.—This is the most important of the alkali factors. It is very common to find in the later specimens from any subject bile in varying quantities ;

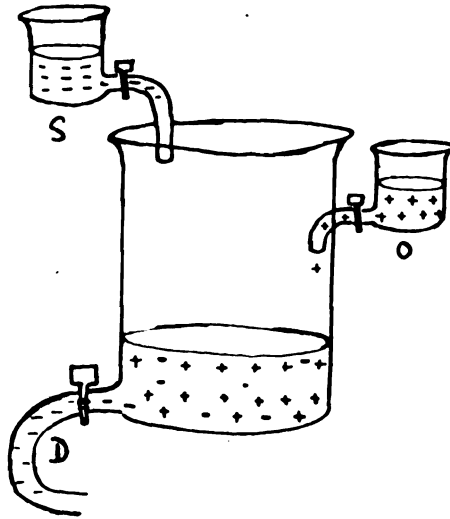


FIG. 1.

The resting stomach. Oxyntic cells, O, giving very slight continuous secretion; saliva, S, negative, pylorus patulous and allowing duodenal regurgitation, D, to occur readily.

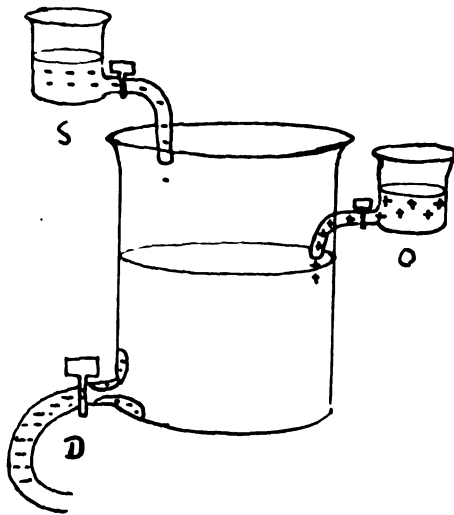


FIG. 2.

Immediately after meal on empty stomach. Stomach filled with neutral gruel; oxyntic cells beginning to secrete acid; saliva flowing; pyloric mucous membrane almost inactive; pylorus closed.

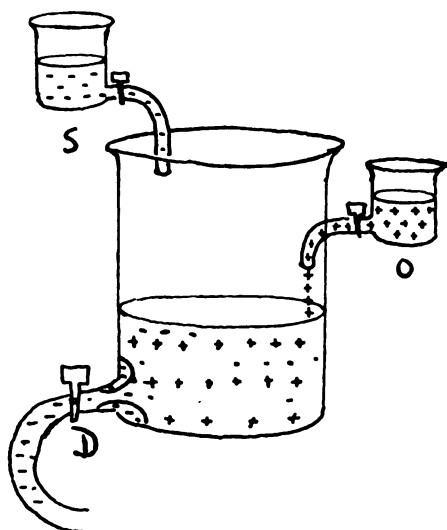


FIG. 3.

Half-way through gastric digestion. Stomach emptying; oxyntic cells secreting freely; saliva negative; pyloric mucous membrane beginning to secrete; pylorus opening at intervals but not much regurgitation yet occurring. Acidity of gastric contents reaching its height.

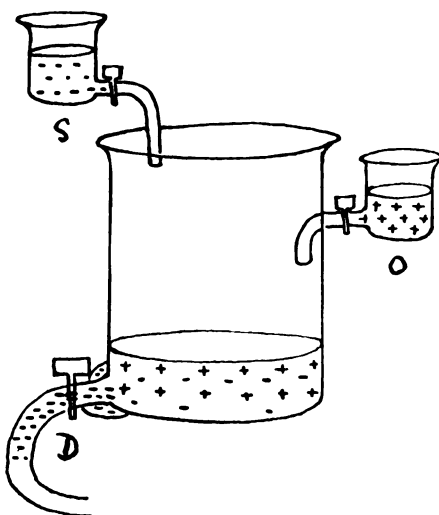


FIG. 4.

End of gastric cycle. Meal emptied; oxyntic secretion minimal; saliva negative; free duodenal regurgitation; pyloric cells secreting; residual acid being neutralised by these factors.

marked depressions of the curve sometimes occur at these points ; but it is also not infrequent to find a greater lowering of the acidity at points where no bile was seen. This is due to regurgitation of pancreatic juice, which is not visible to the naked eye, but whose presence can readily be shown by testing for trypsin, which Rehfuss and his co-workers have shown¹⁶ to be a very common content of the stomach. The whole question of the regurgitation of intestinal contents into the stomach was fully described by Boldyreff,¹⁷ who drew attention to its importance and especially to the rôle of pancreatic juice in lowering acidity ; there is even evidence, as has been shown by Crohn¹⁸ and by Rehfuss,¹⁶ that this duodenal regurgitation may be in somewise a protective mechanism preventing a condition of hyperacidity in the stomach.

(c) *The Secretion of the Pyloric Mucous Membrane.*—This factor becomes of some importance in the more slowly emptying stomachs ; towards the end of gastric digestion it is not uncommon to find an excess of mucus amidst a clear juice of low acidity, this mucus represents largely the pyloric mucus secretion and tends to lower the acidity. In pathological states there is nearly always an inverse relationship between the mucus output and the acidity—achlorhydrics showing relatively excessive mucus and hyperchlorhydrics traces only.

These factors, acid and alkali, we have attempted to represent in the attached diagrams.

Recognition of these principles gives the explanation of the phases usually seen in the chart obtained from a fractional gastric analysis ; such a chart will show :

- (1) An initial acidity corresponding to the degree of continuous oxyntic secretion and the degree of pyloric regurgitation in the resting stomach ;
- (2) a phase of neutrality or very low acidity immediately following the meal ;
- (3) a phase of increasing acidity ;
- (4) a phase of diminishing acidity.

PART II

RESULTS OF THE PRESENT INVESTIGATION

A. THE RESTING-JUICE

WE have already referred (4 and 5) to the very full inquiry which Rehfuss and his co-workers have made into this subject, and it may be said at once that our own findings confirm theirs.

We have found the same range of acidity, some subjects having no free HCl, and others quite a high free and total acidity.

Bile was present in 40 per cent. of our cases, and we have had difficulty in deciding to how great or small an extent the content of the fasting stomach may be considered as truly gastric in origin; saliva forms a certain—we believe inconsiderable—portion of it; mucus and HCl are present as true secretions of the gastric mucosa; and there are also frequently both bile and trypsin regurgitated from the duodenum.

These premises are fully borne out by experiment. Samples obtained may be clear and limpid with a mere trace of mucus, or opalescent, cloudy or even thick and viscid with mucus. The acidity varies inversely with the mucus content. On the other hand the samples may be tinged with bile or may consist of almost pure bile. These variations may be recorded from time to time in the same individual, and are well demonstrated in the experiments by one of us (J. A. R.) recorded below. Further, it is possible to withdraw a clear, apparently gastric specimen, and in the next syringe-ful or the second half of the same syringe-ful to withdraw bile-stained fluid. This has been repeatedly observed by both of us, and suggests very strongly that the presence of bile may sometimes be artificial, and the result of suction exerted through the bulb as it lies close to the pylorus.

The total quantities therefore represent the resting-juice of stomach and duodenum in many cases, and we are of the opinion that the larger amounts obtained sometimes include a high proportion of naturally or artificially regurgitated duodenal juice.

In a series of individual experiments conducted by one of us (J. A. R.) during a period of thirty-one days the resting-juice was examined with the results shown in the table. Unfortunately accurate measurements were not kept, but it may be taken that "ample" and "easily obtained" refer to specimens of 18–20 c.c. or upwards obtained readily, while the other results are self-descriptive.

The total amounts may be taken to have varied from a few c.c. to 30 or 40 c.c. The free acidity varied from 0 to 22 with an average of 7. The total acidity varied from 4 to 38 with an average of 20.

During the period marked A the subject was on a salt-deficient diet; that is to say, he took no salt with his food and none was included in the cooking. The urine chlorides fell from 0.468 per cent. to 0.269 per cent. on the third day and rose to 0.327 per cent. on the seventh day.

During the period marked B the salt-deficiency continued, but 80 grs. a day of pot. acetate were taken as a diuretic. The urine chlorides rose to 0.339 on the tenth and 0.408 on the

TABLE I.

Day.	Amount.	Bile.	Free Acid.	Total Acid.
1	" Easily obtained."	—	0	4
2	" "	—	0	12
3	" "	{ (a) — (b) + }	0	14
4	" "	{ (a) — (b) + }	10	22
5	" Obtained with difficulty."	{ (a) — (b) + }	6	14
A 6	" " "	{ (a) — (b) + }	22	30
7	6 c.c. "obtained with great difficulty."	—	?	?
8	A few c.c. "obtained with great difficulty."	{ (a) — (b) trace }	10	26
9	" Obtained with difficulty at first, then a sudden gush, perhaps due to smell of breakfast."	+	4	22
10	" A few c.c. obtained with difficulty."	—	6	16
11	" A few c.c. obtained with difficulty."	—	16	26
B 12	" A few c.c. obtained with difficulty."	+	0	10
13	?	(a) +++ (b) +++	22	36
14	" Obtained with difficulty."	—	18	30
15	Ample	—	18	38
16	"	—	0	20
17	"	—	4	16
18	"	—	0	16
19	"	—	6	22
20	"	trace	2	16
21	"	"	2	16
22	"	—	12	26
23	"	trace	2	18
24	"	—	12	22
25	"	"	16	34
26	"	—	6	6
27	"	trace	8	20
28	"	—	10	26
29	"	—	0	10
30	"	—	0	10
31	"	?	10	20

twelfth day. On the fourteenth day they were down again to 0.236 per cent.

It is perhaps of interest to note that, excepting in the first three days of salt-deficiency, the specimens were all obtained with difficulty throughout the period of deficiency, whereas neither

before nor on any subsequent occasion has the writer had any trouble in obtaining an " ample " specimen.

It should be mentioned that no effect was produced on the curves of acidity produced in response to standard gruel meals taken at intervals during the period. The curves were closely similar on each occasion and were of the average normal type.

The results of this personal experiment may therefore be summarised as follows :

(1) The character of the resting-juice in a normal individual shows a considerable daily variation as regards its acidity, amount, and bile-content.

(2) No diminution in gastric secretion, immediately after a meal, was observed as a result of a salt-free diet. This corresponding with the observations of Boldyreff,¹⁷ who found that in animals there was re-absorption of chlorides from the small intestine during salt-free feeding, which led to the HCl secretion being unchanged, unless the animal were made to lose chloride through a pyloric fistula.

(3) There is some evidence of diminished resting-juice during a salt-free diet.

Diverse though these findings be, we would not wish to imply that examination of the resting-juice is useless; such experienced clinicians as Labbé¹⁹ and Pron²⁰ have constantly called attention to its importance in pathological cases; we are fully in accord with them in that the presence of food remnants in the fasting stomach is the final criterion of pathological pyloric obstruction, that blood, recent or changed, can often be better detected in the resting-juice than in later specimens, and that cases of hyperchlorhydria, whether physiological or pathological, almost invariably show a high percentage of free HCl in their resting-juice.

The following are the detailed results from our own series.

In thirty-nine cases in which we have carefully measured the total amount of resting-juice the mean figure has been 54 c.c.; the variations from this mean have ranged from 10 c.c., seven cases having 20 c.c. or less, to 150 c.c., five cases having 100 c.c. or more.

Analysis of these rather limited figures appears to show a tendency for the higher amounts to be associated with high HCl, both in the resting-juice and in the subsequent phases of the gastric cycle. Bile was certainly commoner in the larger amounts, supporting our contention in a previous section that these large amounts are partly the product of direct duodenal regurgitation.

These results are tabulated in Table II., explanation of the

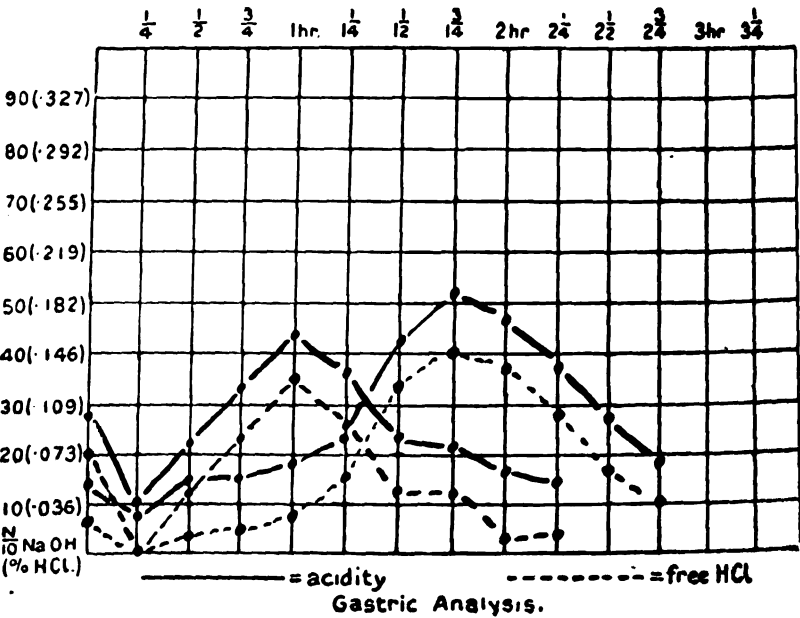
names used to denote types of curve of subsequent gastric acidity being given in a later section.

TABLE II.
ANALYSIS OF CASES IN WHICH THE TOTAL RESTING-JUICE WAS MEASURED.

	Total number of cases.	Free HCl.		Bile.		Type of subsequent curve of Gastric Acidity in response to meal.			
		pre-sent.	absent.	pre-sent.	absent.	Normal Average.	Achlor-hydric.	Climbing.	Quick.
All cases in which R.-J. was measured	39	19	20	17	22	32	3	2	2
Cases with R.-J. of 100 c.c. or more	5	4	1	3	2	2	1	2	0
Cases with R.-J. of 20 c.c. or less	7	1	6	0	7	7	0	0	0

B. THE NORMAL AVERAGE CURVE

In Section D of the first part of this paper we discussed the mechanism of the production of the curve of acidity in fractional gastric analysis, and demonstrated how the various



factors tend to produce a gradually increasing acidity of the gastric contents followed by a fall during the later stages of the gastric cycle.

The majority of our cases, 91 per cent. in all, show curves approximating to this type, which we have been accustomed to speak of as the "normal average curve." At the same time it becomes exceedingly difficult to give any clear expression of what may be considered the true mean of these results. In Chart IV. will be seen, superimposed, curves from two normal

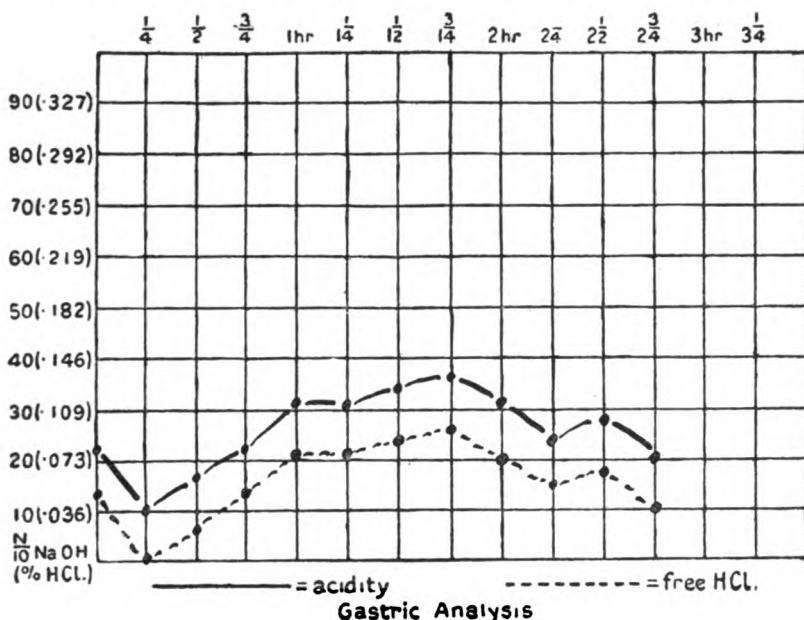


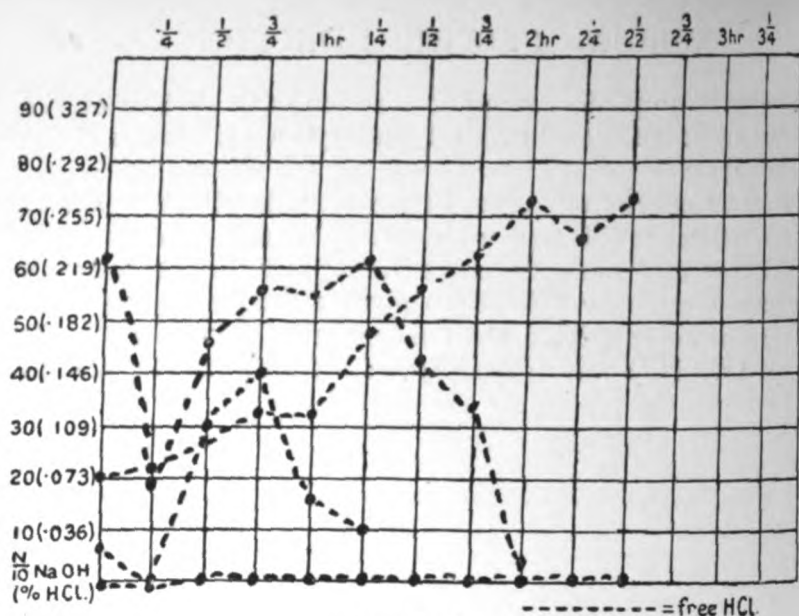
CHART V.

The mean of the curves shown in FIG. 6 to illustrate difficulty in expressing the mean of a series of curves; this curve gives the observer a very fallacious idea of the two previously seen.

men; beyond a difference in the time at which the highest concentration of acidity is reached, there is little difference between them; yet if the arithmetical mean of these two curves be determined it gives the result shown in Chart V., which does not give the observer any true indication of either or both of the two originals.

Still greater is the difficulty when one becomes confronted with wider variations from the average, a group of which has been plotted in Chart VI.

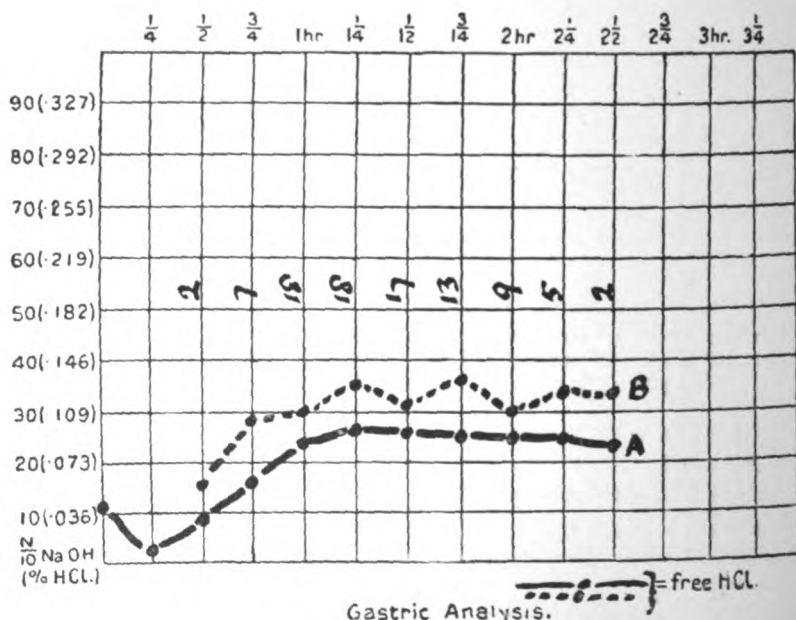
Faced with this difficulty, we have had the benefit of the advice of Professor Karl Pearson, Galton Professor of Eugenics at the University of London; it is, thanks to him, that we have



Gastric Analysis.

CHART VI.

Curves of HCl in four healthy subjects, to illustrate difficulty of expressing the mean of a series. Free HCl alone is plotted in this diagram.



Gastric Analysis.

CHART VII.

The heavy line A shows the curve obtained by taking the mean of all readings at each point; the flattened curve does not resemble closely any normal curve. The broken line B was obtained by calculating the mean of all maximal readings at each point; the numbers above give the number of subjects at each point whose curves reached their highest acid concentration at that point, e.g., at $1\frac{1}{2}$ hours there were 17 subjects whose free HCl was at its highest point, the mean of these 17 readings being 31 c.c. $\frac{N}{10}$ NaOH per cent. Cases of achlorhydria and the curves of the "climbing" type are not included in this last series.

been able to adopt the following expedient. We have, first of all, taken the mean of the readings from all cases at each period of time, at a quarter of an hour, half an hour, three-quarters of an hour, and so on, up to two and a half hours; the curve so determined will be found plotted as a heavy dark line in Chart VII. This curve shows the ascent, followed by a fall, which the majority of cases show, but it shows it as a rise and fall of the most gradual description. Such a result is inevitable when one realises the variations in the times of increasing acidity in different subjects, and the similar variations in duodenal regurgitation and actual emptying time in the later stages of the various curves.

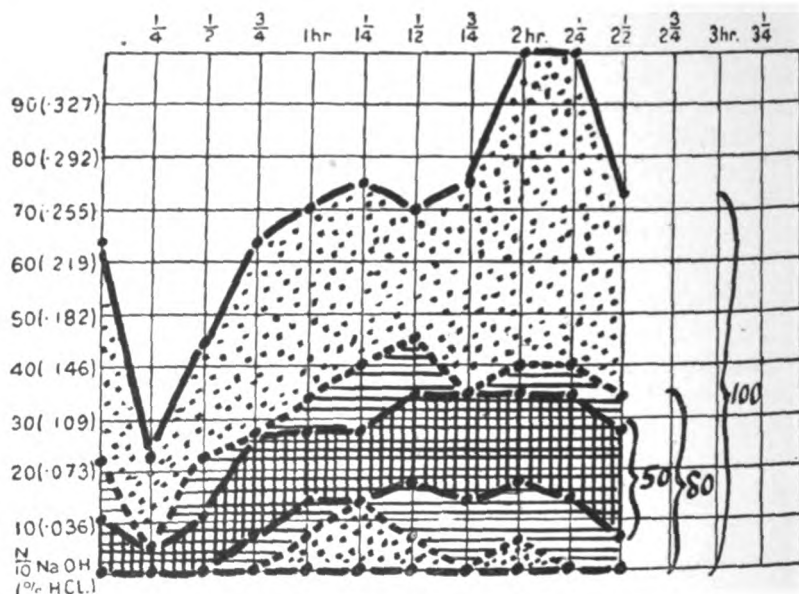
Whilst, therefore, such a curve expresses the true mean of all the curves, it does not closely resemble any of them, and is of little value as indicating to the clinician what is to be considered as the normal average picture of acidity.

It is only by analysing the number and degree of the variations from this mean that we can obtain any accurate information as to this last point.

In Table III. will be found set out the number of readings, at each period of time, classified to show the extent of their variation from the mean reading at that particular period. Two things are immediately apparent from this table; the first is that in the neighbourhood of the mean there is a large number of cases, showing that the usual variation from the mean is not very great; the second is that the total number of readings diminishes as one passes to the right, *i. e.* to the later periods of the gastric cycle. This is, of course, due to the increasing number in which the stomach had become empty before the full two and a half hours. To get a true picture of the extent of variation from the mean, one must, therefore, plot the true mean, and then plot successive bands, or zones, on each side of it showing the extent of variation in increasing proportions of the total cases investigated; as, moreover, certain subjects empty before the full two and a half hours, it is necessary to express these variations as percentages of the total cases remaining at each successive period of time. The result of this method will be seen in Chart VIII., where, in the region of the mean curve, will be seen a darkly shaded band which includes the figures from more than 50 per cent. of all cases; a wider band enclosing this first, and with a more lightly shaded portion above and below it, includes the figures from 80 per cent. of all cases; and, lastly, an irregular zone, larger still, includes every reading in the whole of our series. By comparing any given curve of free HCl with this picture it is easy

to see at once how it compares with the normal average; if several of its readings fall outside the "50 per cent. zone," the observer knows at once that it differs from the usual normal picture. Should several of its readings lie outside the "80 per cent. zone," then the chances of it coming from a healthy stomach are proportionately decreased.

A consideration of this figure, and especially a careful consideration of Table III., leads us to conclude that whilst an



Gastric Analysis.

CHART VIII.

Composite chart to show the variation in free HCl throughout the gastric cycle in 100 normal men. The total shaded area includes the whole of the readings of free HCl in all the cases. The next zone, which excludes only the areas shaded with dots, includes all the readings from 80 per cent. of the cases. The narrowest zone, heavily shaded, includes all the readings from 50 per cent. of the cases. It will be observed that these last two zones agree with the figures given in Fig. 9, and allow a precise estimate to be made of the variation which may be expected to occur from the mean.

estimate of the usual normal picture may be fairly accurately arrived at, yet it is impossible to speak of "isosecretory," "hyposcretory," and "hypersecretory" types as categorically as is done in much of the earlier literature dealing with this subject.

In the next section we will, however, deal with certain of the more definite types of variation from the average.

It must also be observed that the mean of the total readings shown in Chart VII. does not express the mean of the highest

readings of all the curves, because that highest reading occurs at different points on different curves; if the mean of all such highest readings in our series be taken, it is found to be 33 per cent.

$\frac{N}{10}$ NaOH for the ninety-one average normal cases, as shown in Table IV.

TABLE III

AGGREGATE NUMBER OF CASES, FROM THE WHOLE OF OUR SERIES, TABULATED UNDER VARIOUS ACIDITIES, AT THE DIFFERENT PERIODS OF THE GASTRIC CYCLE

$\frac{N}{10}$ NaOH %	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3
96-100									1*	1*			
90-94													
84-88													
78-82													
72-76						1		1	1		1		
66-70					1	0	2	0	0	1	0		
60-64	1			1	1	2	0	2	1	1	1		
54-58	0			1	2	2	2	2	0	0	1	0	1
48-52	2			0	1	6	0	4	3	2	2	1	
42-46	2		1	2	3	0	9	4	3	4	2	3	
36-40	1		2	4	5	9	7	4	4	9	3	2	1
30-34	2		3	5	16	13	11	12	12	11	10	2	1
24-28	8		1	13	17	14	25	18	19	9	4	2	1
18-22	9	2	16	17	21	18	14	13	18	9	8	2	
12-16	12	2	10	27	18	21	8	12	6	12	12	2	
6-10	15	9	21	12	7	3	7	8	8	7	6	3	1
0-4	45	87	44	16	7	7	9	11	9	9	6	4	
Total Cases	97	100	98	98	99	96	94	91	85	75	56	24	5

* These two isolated readings, 104 and 102, come from the subject with the curve of extreme climbing type shown in Chart X. (A).

C. VARIATIONS FROM THE NORMAL AVERAGE ACIDITY

1. The Hypochlorhydric and Achlorhydric Types

Amongst the ninety-one cases in our series which give curves of free HCl approximating to the average type, there are many which give lower readings of free HCl than the mean, and there are altogether nine cases whose HCl never reaches a height of 20 per cent. $\frac{N}{10}$ NaOH. Such cases we have been accustomed to speak of as "hypochlorhydric," without thereby meaning to imply more than a rather wide divergence from the mean. Indeed there is no evidence that any unusual factor is present or usual factor absent in such cases. In Table IV. will be found set out the relation of such cases to rate of emptying and the presence of bile.

Whilst these "hypochlorhydric" cases show no evidence

of being more than a divergence from the mean, there are certain cases which are more surprising; these are the cases with complete absence of free HCl, achlorhydria, or, if the more popular modern nomenclature be adopted, achylia gastrica.

One of these cases has been already described in a previous communication ²¹; since then three more have been met with. Several others have been seen in apparently healthy men investigated by us, but we do not include them in this series, because they give histories of recent or remote gastro-intestinal disease sufficient to account for their present gastric picture.

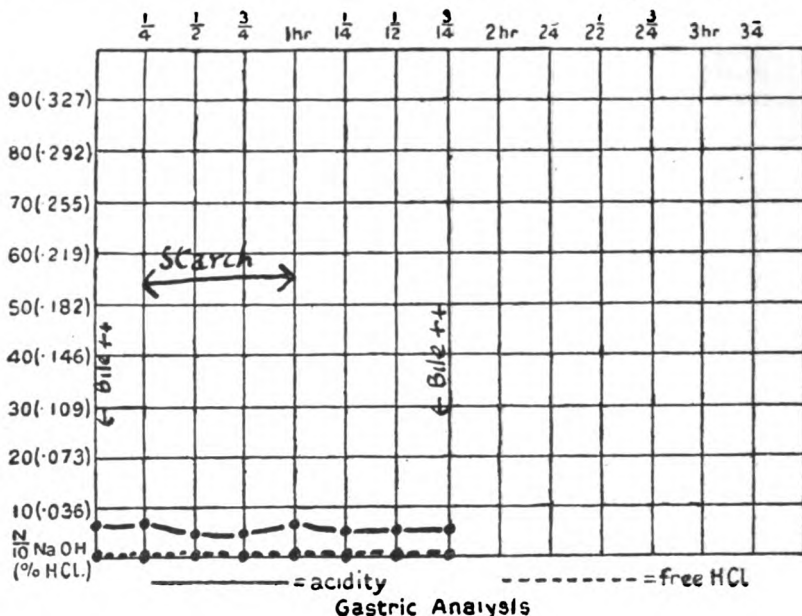


CHART IX.

Subject No. 62. One of four healthy subjects in our series with complete achlorhydria.

In the case of the four included here no such history exists, nor can we detect in them any sign of organic disease.

One of us (J. A. R.) last year published with H. W. Barber ²² an account of the association between acne rosacea and achylia gastrica, and we are inclined to suspect that one of our "normal" cases may be a very early rosacea, but in none of them otherwise can we find abnormal signs or symptoms. A typical chart from one of them is given in Chart IX. Three of the four show the typical rapid emptying seen in the achylia associated with rosacea, gastritis, Addison's anæmia, etc. All of these cases have been confirmed by a second investigation, and by alveolar CO₂ estimations.

2. *The Hyperchlorhydric and "Climbing" Types*

Just as certain normal curves are in shape similar to the average, but never reach the average height of acidity, so there are some of usual shape but at a considerably higher level. In the present series there have occurred five cases, whose free HCl at two points or more in the cycle reached a level of 50 per cent. $\frac{N}{10}$ NaOH, and subsequently fell towards the base line. Such cases we have been accustomed to speak of as hyperchlorhydric, again without thereby wishing to imply more than that they were somewhat extreme divergences from the normal average type.

The relation of such cases to the others, in point of view of emptying rate, duodenal regurgitation, etc., will be seen by consulting Table IV.

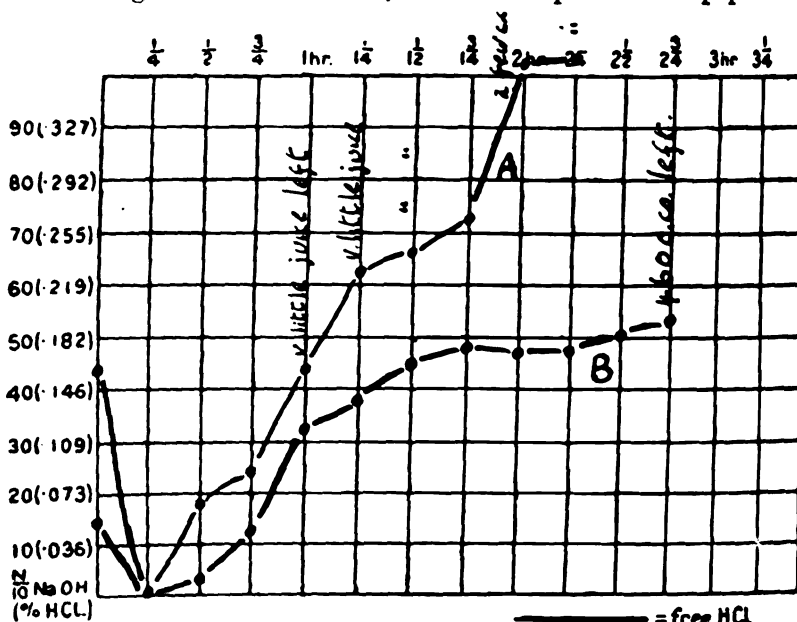
But in addition to these there have been cases with a high acidity whose curves departed from the normal average in that the fall in acidity during the later phases of the gastric cycle is not seen. Such cases, which we speak of as the "climbing" type, give specimens of increasing acidity right up to the last specimen which can be obtained. We are of opinion that study of these cases is of great importance in the elucidation of the problems of disease, especially disease of the stomach and duodenum; for were there any definite gastric symptoms present in these subjects a diagnosis of pre-pyloric or duodenal ulcer, or pylorospasm secondary to organic disease of the gastro-intestinal tract, might logically be made.

Five of such cases occur in our series, the curves from two of them being reproduced in Chart X.; in none of these subjects could symptoms or signs of disease be detected.

In a previous number of these Reports there appeared an article by one of us²³ dealing with this type of curve. To the opinion there expressed we do not wish to add anything at present, beyond pointing out that such "climbing" curves must be the result of acid-production which is continuously in excess of the factors tending to produce gastric neutrality or alkalisation. Such an hypothesis does not necessarily imply that hypersecretion is constantly present in these cases, nor do we believe that it is. In Chart X., for instance, the acid-curve marked A comes from a subject whose stomach was nearly empty at one and a quarter hours, the subsequent specimens being obtained with great difficulty. As contrast, the subject from whom curve B was taken had, at the end of two and three-quarter hours, 460 c.c. of fluid remaining in his

stomach; it is clear that the total quantity of gastric juice secreted by this latter subject is very much greater than that secreted by A, though its concentration does not reach nearly so high a figure.

Remarkable confirmation of these findings is supplied by the work of E. C. Dodds, which has been referred to in the concluding lines of section A, in the first part of this paper.



Gastric Analysis

CHART X.

Curves of free HCl given by Subjects 81 (A), and 87 (B), two of the five curves of the "climbing" type occurring in our series.

The relation of curves of this type to emptying-rate, etc., may be seen by consulting Table IV.

TABLE IV

TO SHOW RELATION OF VARIOUS TYPES OF NORMAL GASTRIC CURVE TO EMPTYING-RATE, BILIARY REGURGITATION, ETC.

Type.	Total No. of cases.	Mean maximum free HCl.	Mean emptying-rate.	No. of cases in which there occurred Biliary Regurgitation.		
				1st hour.	2nd hour.	Later.
Normal Average . . .	91	33	1.9	10	32	39
High Normal Average	7	58	2.0	1	5	5
Low Normal Average	9	16	1.8	2	3	4
Achlorhydric . . .	4	0	1.1	0	3	—
"Climbing" . . .	5	70	2.2	0	1	2
"Quick" . . .	6	31	.75	1	—	—

D. TOTAL ACIDITY AND FREE HCl

Reference to acidity in previous sections of this paper is chiefly concerned with free HCl; we have in all cases made determinations of the total acidity as well, and these figures show that in the normal cases of all types the relation is a remarkably constant one.

We have been informed that American workers are accustomed to take, as their end-point for phenolphthalein, a definite bright red; we have ourselves taken a definite change towards this colour as our end-point, which may lead to our figures being slightly lower than theirs; in any case the error would not exceed 2 per cent. $\frac{N}{10}$ NaOH.

Analysis of all our figures of total acidity shows that their mean runs parallel to the curve of the mean free HCl, at a level about 10 per cent. $\frac{N}{10}$ NaOH above it. Cases with an abundant secretion of mucus show a greater difference than this, amounting to about 18 per cent. $\frac{N}{10}$ NaOH in some cases, but any difference greater than this suggests some abnormal factor.

E. THE RATE OF EMPTYING OF THE NORMAL STOMACH AND THE "RAPID" TYPE OF CURVE

Very little appears in the American literature, to which we have had access, with reference to the emptying-rate of the normal stomach after an Ewald meal or the gruel meal. In their original article² Rehfuess, Bergeim and Hawk state, "whilst normally there are marked variations in acidity, there is little variation in the motor power in health"; Crohn and Reiss, writing as recently as this year,²⁴ say "in hundreds of cases observed with a functionally normal digestive organ, the stomach empties itself promptly at two hours, and thereafter no further secretion is obtainable."

With these opinions we cannot too emphatically disagree. That the fractional method supplies a valuable method of measuring gastric motility has long been held by all who employ it; this view we share, nor have we ever found that our results, obtained in this way, were at variance with those obtained by accurate radiographic examination.

Naked-eye examination of the specimens withdrawn gives an index not only of the moment of complete emptying, but enables the observer to estimate the period at which emptying

begins, the moment when the meal has left the stomach, and the disappearance of the post-prandial secretion. Levy, who has studied this particular subject, advocates²⁵ the use of the Einhorn-tube as being more accurate than x-rays for gauging the emptying-rate of the stomach.

We have kept records of the moment of disappearance of starch in every case in our series; the mean emptying-rate is 1.9 hours, but to say that there was little variation from that mean would be grossly inaccurate. The actual variation is shown in Table V., from which it will be seen that in nine of our cases starch was no longer present in the stomach after the first hour, in thirty-seven more it left the stomach during the course of the second hour, and in twenty-two it was still present at two and a half hours.

We have attempted in Table IV. to show such relation as exists between motility and acidity, and it will be seen that the cases of the climbing and hyperchlorhydric types tended to empty more slowly than the average, whilst those of low acidity, and especially the completely achlorhydric cases, emptied more rapidly.

Here attention must be specially called to those cases in which motility was most marked; several of these subjects stated that their appetite was very vigorous; Subject 47 actually volunteered the statement that on reaching the hospital in the morning he "always felt ready for a second breakfast."

Apart from the cases of achlorhydria, we believe that there is a very definite group of normal subjects, who show a gastric acidity of normal range, but whose stomachs are so motile that they empty with extreme rapidity; altogether six of our cases fall into this "rapid" group, examples of which are reproduced in Chart XI. In the case of one of our subjects, Number 73, emptying is so rapid that an estimation of his secretion of acid is not possible by ordinary methods; no specimen could be obtained after half-an-hour at any of several examinations made, and whereas in the first examination free HCl was present in his resting-juice, but not in either of the two subsequent specimens, in the later examinations there was no free HCl in the resting-juice, but the scanty specimen obtained at half-an-hour contained free HCl equal to about 18 per cent. $\frac{N}{10}$ NaOH.

Examined by Dodds' alveolar CO₂ method he shows a definite but exceedingly transitory rise in response to an ordinary meal. It is clear that in subjects with stomachs of exceptional motility, the gastric contents may be passed on into the intestine before the secreted HCl has had time to affect the reaction of

the meal; such cases must, however, be exceedingly rare. The other five subjects whom we have placed in this group, give, each of them, a curve similar to those illustrated in the figure, *i. e.* the HCl reaches a height of about 35 per cent.

$\frac{N}{10}$ NaOH at the end of three-quarters of an hour; there is then a fall towards the base line, and usually after one and a quarter hours the stomach is completely empty.

We have had exceptional facilities for checking these results,

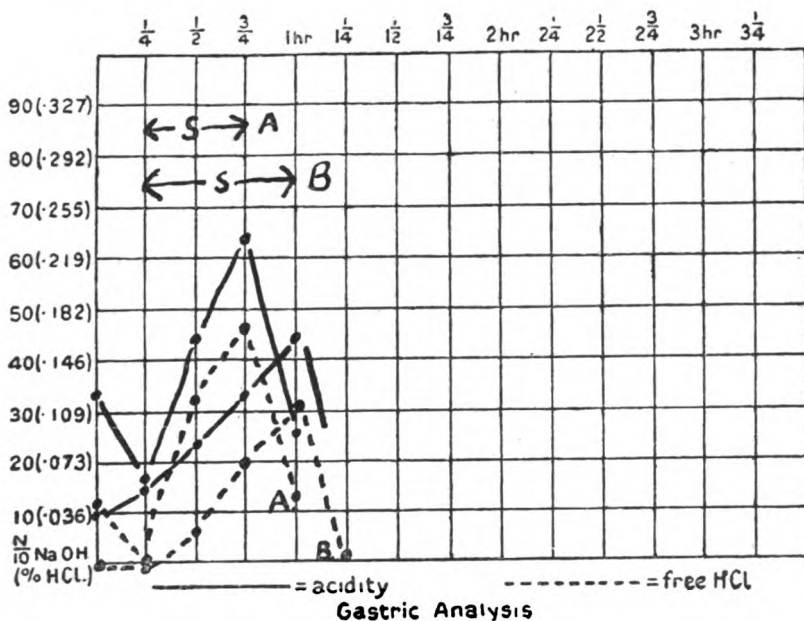


CHART XI.

Curves from Subjects 18 (A) and 43 (B) to illustrate the "rapid" type of case; in both of these subjects the stomach is completely empty after the last reading shown above.

as several of these cases kindly volunteered to act as subjects for an extended series of experiments on gastric problems.

TABLE V

TO SHOW THE VARIATION IN EMPTYING-RATE OF STOMACH OF 100 NORMAL MEN
AFTER TAKING A MEAL OF 1 PINT OF OATMEAL GRUEL

Time of specimen giving the last reaction for starch	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$ and upwards
Number of cases	1	5	3	7	13	17	14	18	22
Total Cases	100		Mean emptying-rate 1.9 hours.						

SUMMARY

1. One hundred healthy medical students have been investigated by the fractional method of gastric analysis, the technique following closely that of Crohn and Reiss.

2. (a) In thirty-nine cases, in whom the total resting-juice was measured, it was found to vary in quantity from 10 c.c. to 150 c.c. with an average figure of 54 c.c.

(b) Subjects with larger amounts of resting-juice were found usually to give higher figures of free HCl both in the resting-juice and in subsequent phases of the cycle of gastric digestion.

(c) Bile was present in 40 per cent. of cases in the resting-juice.

3. (a) The percentage of free HCl in the gastric contents of ninety-one of our subjects was found to show a steady increase immediately after the meal, with a subsequent fall towards the original concentration at later periods.

(b) The mean maximum percentage of HCl in these cases was 33 per cent. $\frac{N}{10}$ NaOH, or 0.118 per cent. HCl.

(c) The extent of variation from this mean may be indicated by the fact that seven of these cases gave readings of free HCl exceeding 50 per cent. $\frac{N}{10}$ NaOH on two or more occasions, whilst nine never reached 20 per cent. $\frac{N}{10}$ NaOH.

4. Of the remaining nine cases in our series four showed a complete absence of HCl at all periods, and five gave constantly increasing concentrations of HCl, being of the "climbing" type which is met with in pathological cases with ulceration in the pyloric region. All the subjects were without sign or symptom of past or present disease.

5. The total acidity in our cases followed a curve of concentration parallel to the curve of free HCl at a level about 10 per cent. $\frac{N}{10}$ NaOH higher.

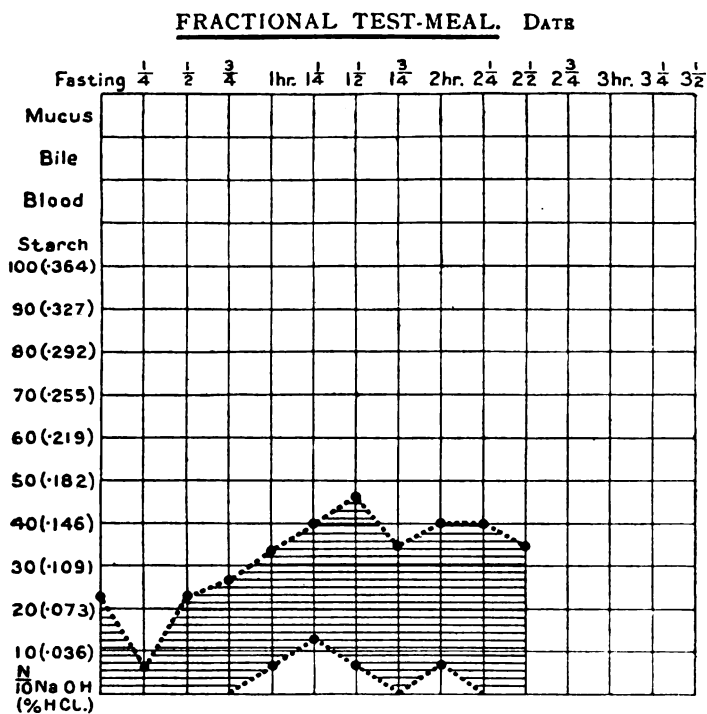
6. Contrary to previous observers, we find that there is a marked absence of uniformity in gastric motility in health; the average emptying-time in our series was 1.9 hours, but nine cases emptied during the first hour, and twenty-two still had starch present at two and a half hours.

7. Six of our cases showed an acid-curve of normal form, but were distinguished by the fact that the whole gastric cycle was remarkably rapid, their stomachs being completely empty one and a quarter hours after the meal.

8. Apart from these, the cases with high acidity tended to empty more slowly than the average, whilst those with low acidity, and especially those with complete achlorhydria, emptied more rapidly.

9. We have found no justification for the classification of normal cases under such headings as isosecretory, hypersecretory and hyposecretory.

We have prepared the following chart with the aid of the results obtained in this investigation for the purpose of recording the results of gastric analyses in pathological subjects. Curves falling outside the shaded area may be considered as showing departures from the normal.



The shaded area represents the limits of free HCl in 80 per cent. of healthy males. The average emptying-rate, as judged by disappearance of starch, is two hours.

We wish once more to express our thanks to the one hundred students of Guy's and the Middlesex Hospital, who served as subjects for this investigation, for all the help they have given us. In addition, we would like to acknowledge an equal debt towards a very large number of their fellows who also were investigated, but from whom the results had to be rejected on account of a

history or symptoms of various gastro-intestinal disturbances. We would also like to thank Professors M. S. Pembrey and Swale Vincent for the laboratory facilities and assistance which they have given us; Drs. A. F. Hurst and E. L. Kennaway, and Professor James McIntosh for valuable advice and criticism; and Messrs. F. C. Mason, E. C. Dodds, A. Osman, M. Maizels, and Dr. E. Fairfield Thomas for their assistance in carrying out the numerous titrations.

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JEJUNAL AND GASTRO-JEJUNAL ULCERS

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital, and
R. P. ROWLANDS, M.S., Surgeon to Guy's Hospital.

GASTRO-JEJUNAL and jejunal ulcers form the most serious complications of gastro-jejunostomy, an operation which is, however, exceedingly satisfactory in a large majority of cases. It is clearly important to investigate their cause, and, if possible, to learn how they may be prevented.

DEFINITION

A gastro-jejunal ulcer is one which forms in connection with the stoma after gastro-jejunostomy and involves both the stomach and jejunum. It may encircle the stoma, and then tends to narrow the opening, which may finally become completely closed. Jejunal ulcers, which are twice as common as gastro-jejunal ulcers, develop in the jejunum opposite the anastomosis and in the first four inches of the efferent limb of the jejunum. It is doubtful whether an ulcer ever involves the afferent limb. The ulcer is generally shallow, but it may be deep and occasionally invades the pancreas or the transverse colon, into which it may ultimately perforate.

ETIOLOGY

It is very difficult to estimate the frequency of gastro-jejunal and jejunal ulcers, as only a comparatively small proportion of cases ever come to operation. In 48 (1·3 per cent.) out of the 3,700 cases, in which gastro-jejunostomy had been performed for non-malignant disease of the stomach in the Mayo Clinic up to 1919, a second operation had to be performed for gastro-jejunal ulcer. This can, however, only represent a small proportion of the cases in which the complication arose, as several were doubtless operated upon subsequently at other clinics, and a still larger number would never come to operation at all. Eustermann⁷ states that in the cases operated on at the Mayo Clinic men preponderated over women in the proportion of 7 to 1, although gastro-enterostomy was performed only three times as often in men as in women.

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PATHOGENESIS

One essential factor in the development of gastro-jejunal and jejunal ulcers is the presence of free hydrochloric acid. Simple ulcers only occur under natural conditions in the stomach and first part of the duodenum, because free hydrochloric acid is never present anywhere else, but after the performance of gastro-enterostomy for non-malignant disease of the stomach the

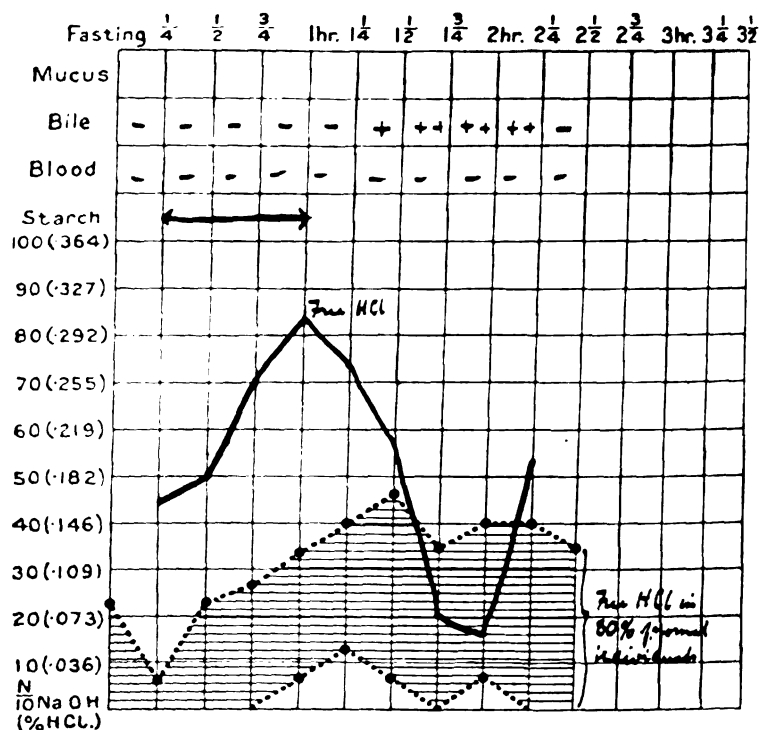


CHART 1.

Fractional test-meal nine years after gastro-enterostomy for duodenal ulcer. No symptoms, but hyperchlorhydria persists and entry of duodenal contents is deficient (J. J. Conybeare).

first few inches of the efferent limb of the jejunum may also come in contact with the acid secretion of the stomach. The importance of the presence of acid is shown by the following facts.

(1) Gastro-jejunal ulcers rarely, if ever, occur after gastro-jejunoscopy for malignant disease, although the poor general condition of the patient might be expected to predispose to the formation of an ulcer. This immunity is almost certainly due to the absence of free hydrochloric acid in the vast majority of cases of carcinoma of the stomach.

(2) Ulcers are more common after gastro-jejunostomy for duodenal ulcer, in which hyperchlorhydria is constant, than it is after an operation for gastric ulcer, in which hyperchlorhydria is rare, though hypersecretion occurs if the pylorus is involved. Moreover, as one of us (A. F. H.)⁹ has shown the hyper-tonus and hyperchlorhydria associated with duodenal ulcer are probably not due to the ulcer, but are present before it develops and persist after it has healed, whether as a result of medical

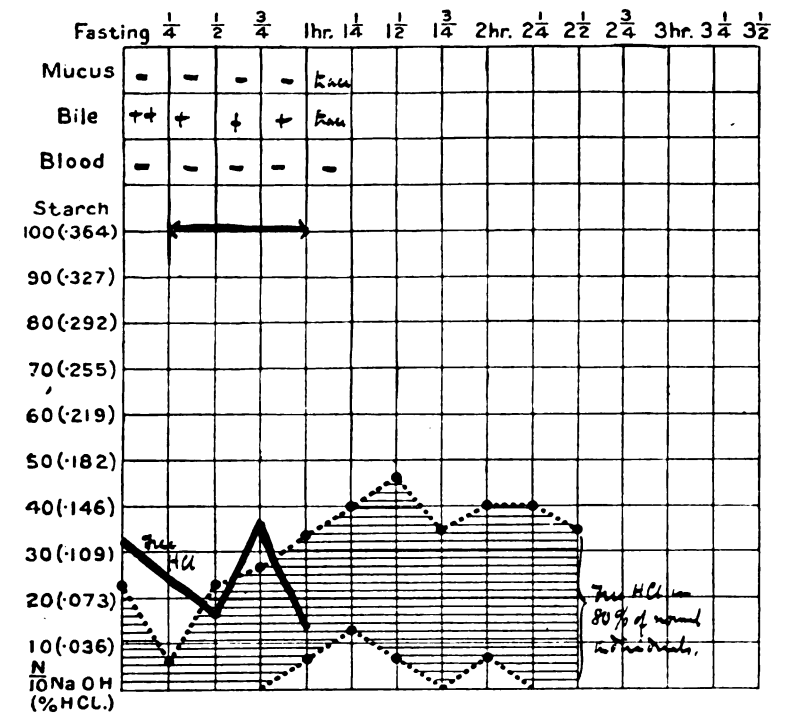


CHART 2.

Fractional test-meal in case of jejunal ulcer of two years' duration, beginning two years after gastro-jejunostomy for duodenal ulcer. Stomach empties rapidly, but acidity is high considering presence of duodenal contents.

or surgical treatment. On the other hand, the hypersecretion in gastric ulcer involving the pylorus is secondary to the gastric stasis, and disappears directly this is overcome by a gastro-enterostomy.

Dr. J. J. Conybeare, in some unpublished investigations on the effects of gastro-enterostomy, has found by fractional test-meals that the curve (Chart 1) obtained in cases in which the operation has been performed for duodenal ulcer is similar to, though slightly lower than, that characteristic of duodenal ulcer before operations. On the other hand, in cases of gastric ulcer

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more or less complete achylia is generally present after operation. These results are obtained whether any symptoms are present or not after the gastro-enterostomy. They indicate that the addition of the alkaline duodenal contents is insufficient to overcome the hyperchlorhydria, which occurs in patients who are liable to duodenal ulcer, but is sufficient to neutralise more or less completely the less acid gastric juice of patients who develop gastric ulcer.

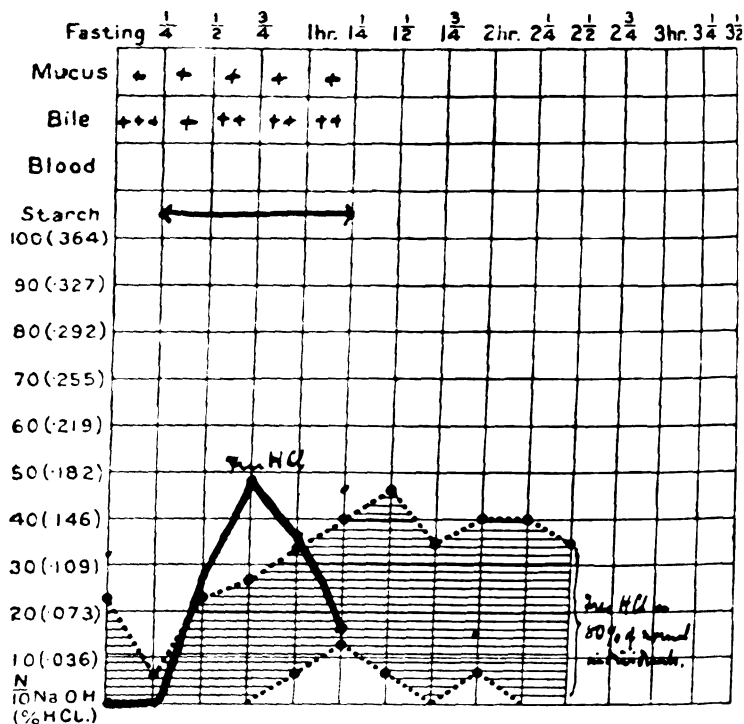


CHART 3.

Fractional test-meal in case of jejunal ulcer of two years' duration, beginning a few months after gastro-jejunostomy for duodenal ulcer. Rapid evacuation, but high acidity considering admixture with duodenal contents.

(3) Persistence of free hydrochloric acid in the gastric contents is invariably found when a gastro-jejunal ulcer is present (Charts 2, 3 and 4), whereas in other cases, unless it has been performed for duodenal ulcer, test-meals show that the operation often leads to its more or less complete disappearance (Chart 6) owing to the thorough admixture with the alkaline bile, pancreatic and duodenal secretions, which enter the stomach by the afferent limb of the jejunum. Any obstruction at or near the stoma, hindering the flow of the alkaline contents from the duodenum into the stomach, is likely to be

followed by jejunal ulceration. In two of our cases, however, there was an excess of bile in the stomach, but this was insufficient to overcome the hyper-acidity. This was probably due to the exit of chyme into or along the jejunum being obstructed, so that it accumulated in the stomach and was only incompletely neutralised by the alkaline juices coming from the duodenum (Chart 5).

(4) As Paterson¹ first pointed out, gastro-jejunal ulcers are

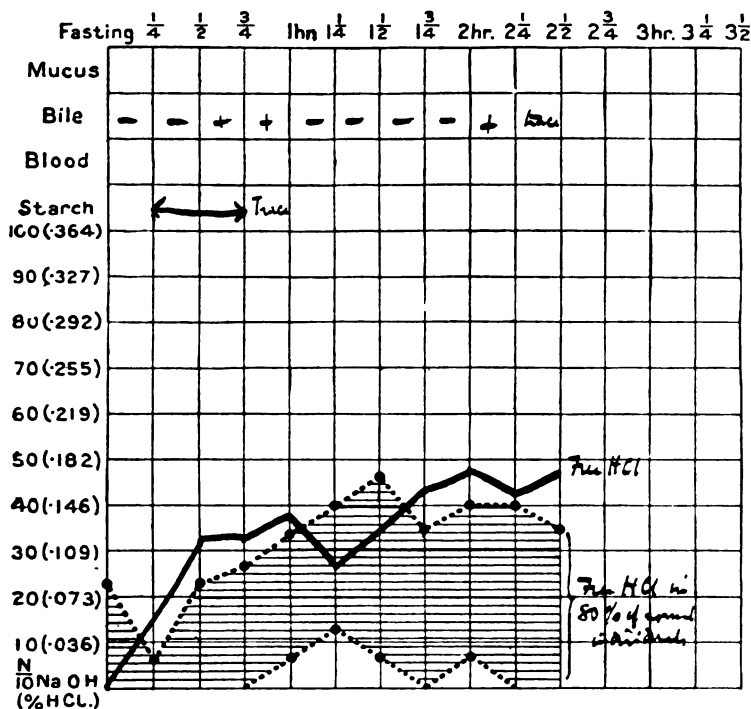


CHART 4.

Fractional test-meal nine years after gastro-jejunostomy for duodenal ulcer. Hyperchlorhydria and hypersecretion persist, and evacuation rapid. X-rays show all food leaves by stoma and none through pylorus. Haemorrhage (melæna) from a jejunal ulcer four years ago (J. J. Conybeare).

most frequently observed after anterior gastro-enterostomy, the "en-Y" operation, and gastro-enterostomy combined with entero-anastomosis, as after these operations the drainage of the stomach is not accompanied by more or less complete neutralisation of the acid gastric contents.

The presence of free hydrochloric acid is not by itself capable of giving rise to a gastro-jejunal or jejunal ulcer, as it is often found in the stomach after gastro-enterostomy in cases in which

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the result is entirely satisfactory (Chart 1). Some other factor must therefore always be present.

The use of unabsorbable sutures may prevent complete healing at the site of anastomosis, but a suture was found hanging loose at the site of the anastomosis in only 14 out of 84 cases operated on at the Mayo Clinic, and it was clearly not responsible for the occurrence of the ulcer in more than half of these (Eustermann).⁷ C. H. Mayo⁸ found silk thread in four cases four

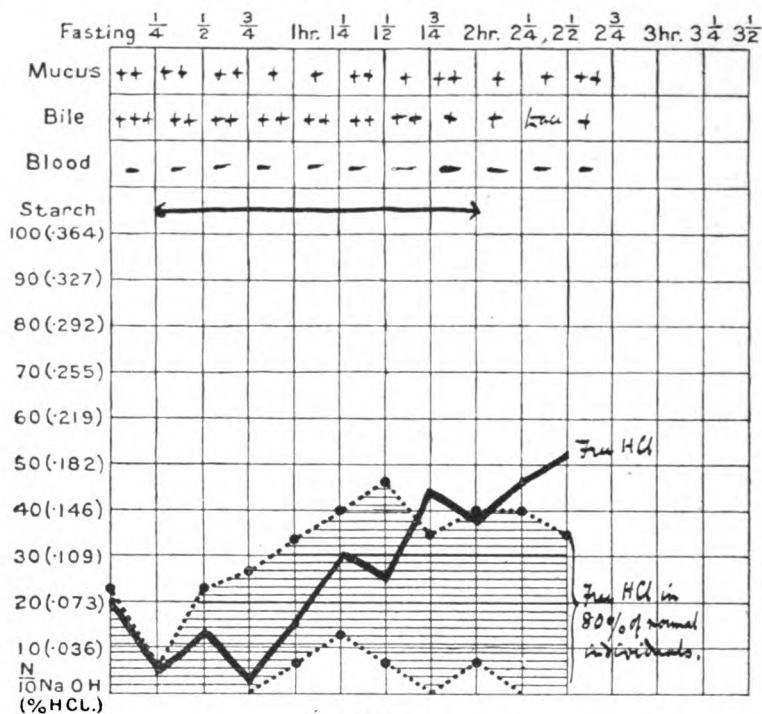


CHART 5.

Fractional test-meal in case of gastro-jejunal ulcer after gastro-enterostomy performed 19 months ago for duodenal ulcer. No acceleration of evacuation following gastro-enterostomy. Average amount free HCl (less than in duodenal ulcer, but more than usual after gastro-enterostomy).

years after gastro-jejunostomy, but it is hardly conceivable that a suture should remain *in situ* and cause ulceration after a still longer interval than this, although cases of gastro-jejunal ulcer may even develop ten years after the operation. It is, however, possible that ulceration primarily caused by unabsorbable sutures may persist long after the suture has disappeared. That unabsorbable sutures are not the only cause of gastro-jejunal ulcers is also proved by the fact that the latter have been found several times in cases in which absorbable sutures were known to have been used (Eustermann).

In many cases the anastomosis has not been properly performed. At all the operations on jejunal ulcer performed by one of us (R. P. R.) the opening was found to be too small or ill-placed for effective drainage, or there was kinking at or near the anastomosis.

The exciting cause of the ulcer is probably the same in most cases as that of the original gastric or duodenal ulcer, for which the operation was performed. It is not surprising that a

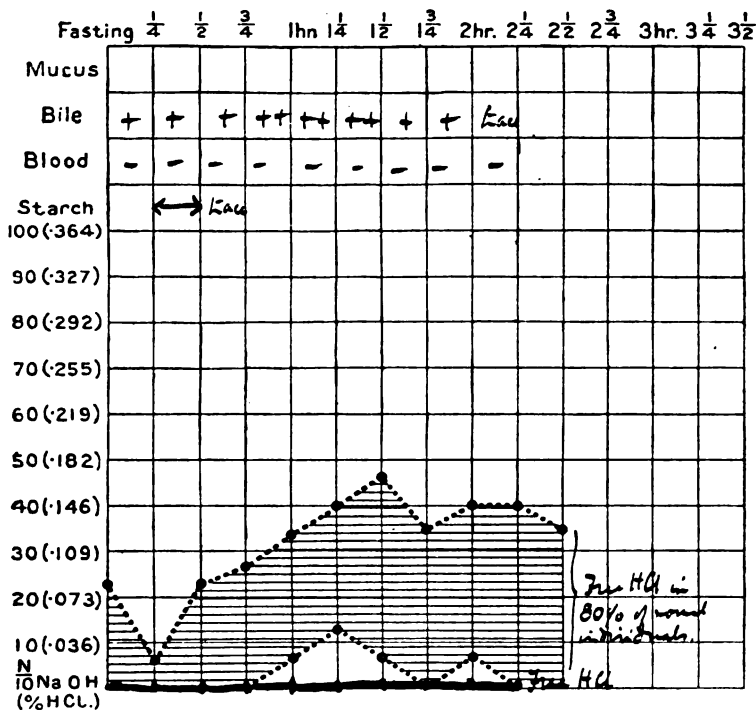


CHART 6.

Fractional test-meal nine years after gastro-enterostomy for ulcer on lesser curvature. No symptoms except distension after meals. Complete achlorhydria and rapid evacuation. X-rays shows all food passes out of stoma and none through pylorus (J. J. Conybeare).

secondary ulcer should occur when free hydrochloric acid is still present if this cause has not been removed. Among the most important exciting causes, which are found to be still present, are infective foci in connection with the teeth, pharynx, appendix or gall-bladder. It is also possible that infection may occur from a chronic gastric or duodenal ulcer, which has not healed. Insufficient mastication, indigestible food, excessive alcohol and excessive smoking are additional factors, just as they are in the production of the primary ulcer.

Most gastro-jejunal and jejunal ulcers are chronic, but an acute ulcer may develop and even perforate within a fortnight of the operation. The recent researches of Flint⁵ have shown that the line of anastomosis forms a healing ulcer throughout this period; infection of the area from septic foci, which have not been removed, as they should, before or during the operation, is undoubtedly the cause of these acute cases.

SYMPTOMS

The symptoms of gastro-jejunal and jejunal ulcer are generally preceded by a normal interval of a few weeks to several years after the gastro-jejunostomy, and they have even developed as long as seven and ten years later. In the 84 cases collected from the Mayo Clinic by Eustermann 80 per cent. never lost their symptoms completely after the primary operation; in 35 per cent. additional cases the symptoms developed within six months and in another 21 per cent. between six and twelve months; the onset was delayed for more than a year in only 14 per cent. of cases.

The symptoms are similar to those of gastric or duodenal ulcer, but the time of onset of the pain is more irregular and is generally earlier after meals. The pain is almost invariably situated to the left of the middle line about on a level with the umbilicus instead of being in the centre or right of the epigastrium. It is sometimes aggravated by exercise, particularly by twisting or bending; this is most likely to occur if the ulcer is adherent to the anterior abdominal wall. The patient may also complain of nausea, vomiting and flatulence. He may so restrict his diet in his efforts to prevent the pain that much emaciation may result.

Hæmatemesis or more frequently melæna may occur without any previous symptoms, or after a short period of indigestion or as an incident in cases with chronic indigestion. Severe anæmia may result. In one case severe recurrent hæmorrhage took place at intervals with no other symptom, beginning two years after gastro-enterostomy had been performed for a duodenal ulcer. When first seen by one of us (A. F. H.) two years later the red corpuscles only numbered 3,620,000 per cmm., the hæmoglobin percentage being 60. A fractional test-meal often shows the presence of occult blood in one or more specimens, and in the majority of cases occult blood is found in the stools.

Local tenderness is frequently present near the seat of the pain and is generally associated with muscular rigidity. In

some cases a definite swelling or induration is felt, due to plastic peritonitis with adhesions to the abdominal wall, and in rare cases a cutaneous fistula has formed, especially when the original operation was an anterior gastro-jejunostomy.

Fractional test-meals invariably show that free hydrochloric acid is present, sometimes in excess (Charts 2, 3, 4 and 5). Traces of blood may be present in some fractions, and more or less bile is found in all, except in rare cases in which the afferent limb of the jejunum is completely obstructed.

With the x-rays an opaque meal can be seen leaving the stoma. Palpation under the screen then shows that the tenderness is strictly localised to the stoma (Fig. 1) or to some point

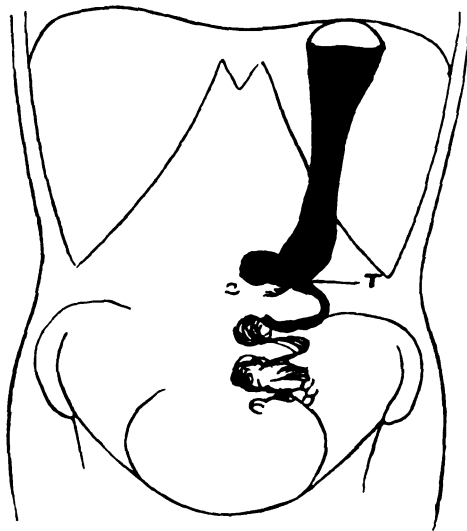


FIG. 1.

Gastro-jejunal ulcer after gastro-enterostomy for duodenal ulcer. T = point of maximum tenderness. Same as chart 5.

in the first four inches of the efferent limb of the jejunum (Fig. 2), this being the only means by which gastro-jejunal and jejunal ulcers can be distinguished from each other. In early cases the stomach empties itself rapidly (Chart 2), as it does after an ordinary successful gastro-enterostomy (Chart 1). In chronic cases, the stoma may become obstructed; a fractional test-meal and the x-rays then show delay in evacuation (Chart 5), and the latter may also reveal exaggerated peristalsis and dilatation of the stomach if the pylorus is also obstructed. The same signs occur if the efferent limb of the jejunum is obstructed owing to faulty technique (Fig. 3). In rare cases some deformity in the region of the stoma can be recognised with the x-rays.

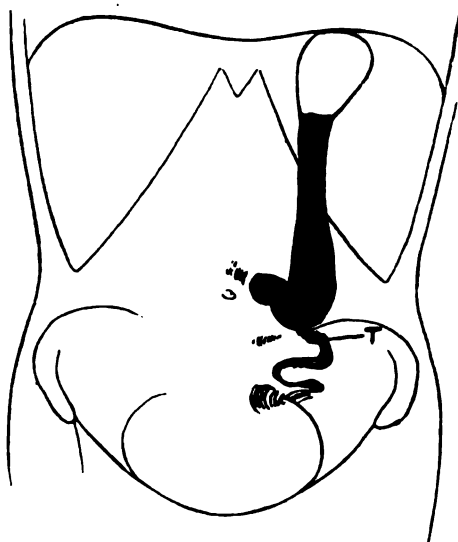


FIG. 2.

Jejunal ulcer after gastro-jejunostomy for duodenal ulcer. T = point of maximum tenderness. Same case as chart 3.

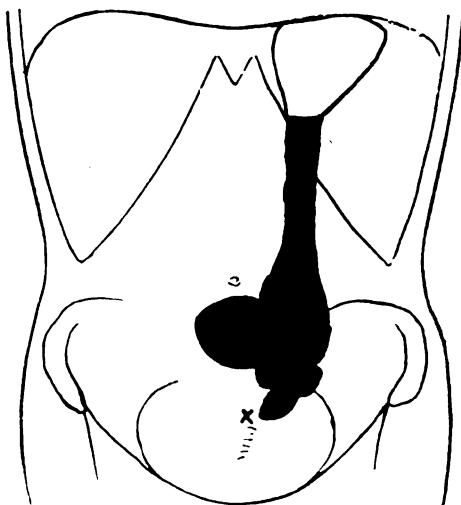


FIG. 3.

Jejunal ulcer with symptoms persisting for nine years after gastro-jejunostomy for pyloric obstruction, due to partial obstruction at X of efferent limb of jejunum. The stomach was dilated and emptied slowly.

DIAGNOSIS

When symptoms recur after gastro-jejunostomy, the possibility of jejunal ulceration should always be considered. We believe it is far more common than is generally supposed. It has to be distinguished from persistence or recurrence of duodenal or gastric ulcer, chronic appendicitis or gall-bladder disease overlooked at the time of the first operation or possibly developing at a later date, and carcinoma supervening upon an unhealed gastric ulcer or originating at the stoma.

When the x-rays show that all the gastric contents pass out of the stoma and nothing reaches the duodenum by way of the pylorus, it can be confidently assumed that the symptoms are not due to recurrence or persistence of ulceration of the duodenum. The recurrence or persistence of a gastric or duodenal ulcer leads to the same symptoms as before the operation, the position and time of occurrence of the pain being unaltered. As already pointed out, the pain and tenderness in gastro-jejunal and jejunal ulcer are to the left of the middle line and lower down than in duodenal ulcer. Moreover the pain is more capricious and intractable. The pain never begins immediately after meals in cases of duodenal ulcer, and a considerable proportion of the food is seen with the x-rays to pass through the pylorus.

Fullness and discomfort to the left of the umbilicus immediately after meals, often associated with diarrhoea, are common after gastro-jejunostomy, and do not point to the presence of ulceration. One of us (A. F. H.)³ has previously described the cause and treatment of these symptoms.

COMPLICATIONS

The development of a gastro-colic fistula leads to the occurrence of foul eructation, faecal vomiting, diarrhoea with undigested food in the faeces, and wasting. A radiographic examination after an opaque meal or enema confirms the presence of a fistula, and faecal material is found in the gastric contents. One of us (R. P. R.) has operated upon three cases of this complication, in one of which there was an additional fistula into the ileum with intestinal obstruction. Symptoms of intestinal obstruction or of general or local peritonitis may occur with or without previous symptoms.

PROPHYLAXIS

If gastro-jejunostomy were only performed when there is a visible and palpable ulcer or stenosis of the pylorus or

duodenum; if before the operation every possible source of infection in the mouth and pharynx were removed; if at the operation any associated disease of the appendix or gall-bladder were dealt with; if after the operation the patient were given adequate instructions with regard to diet and told to take additional feeds between meals; if moderation in smoking and the taking of olive oil before meals and alkalies after were also enjoined; then the chances that a gastro-jejunal or jejunal ulcer might develop would be reduced to a minimum. Under such conditions these complications would rarely if ever arise in the absence of some gross error in technique.

TREATMENT

Strict medical treatment on the lines recently laid down by one of us (A. F. H.)⁹ should be very thoroughly tried, and the patient should then be given definite instructions with regard to diet and the other precautions necessary to take in order to avoid any chance of recurrence. It is extremely important to eradicate every possible source of infection in the mouth, pharynx or elsewhere. In the early stages this almost invariably succeeds, but it can clearly be of little avail when the x-rays show definite obstruction in either limb of the jejunum.

The surgical treatment of jejunal ulceration may be very difficult owing to extensive adhesions or the poor general condition of the patient. A long incision in the left epigastric angle extending a little below the umbilicus gives the best access. Moreover it has the merit of avoiding adhesions near the old incision to the right of the middle line. The treatment of (1) perforation, (2) chronic jejunal or gastro-jejunal ulcer, and (3) gastro-jejuno-colic fistula will be discussed separately.

(1) *Perforation of a jejunal or gastro-jejunal ulcer.* This is a grave event, usually more serious than the perforation of a gastric or duodenal ulcer, because the extravasation spreads more rapidly and with less hindrance amongst the coils of small intestines and into the pelvis. Moreover the condition of the patient when perforation occurs is generally worse. It is therefore imperative to operate without delay.

As a rule the patient is much too ill for any radical operation to be contemplated. Gauze rolls are passed into the pelvis and flanks to absorb all the peritoneal effusion while the perforation is found and closed with catgut sutures. The stitches must be passed parallel to the axis of the stoma so that the latter may not be further reduced in size. A short rubber drainage tube is inserted through a stab wound above the pubes.

The operation should be followed by a prolonged period of rest and medical treatment with the object of avoiding the necessity of any further surgical interference.

(2) *Chronic jejunal or gastro-jejunal ulcer.* When medical treatment has been thoroughly tried and has failed, an operation should be advised. In any case it is wise to insist on complete rest in bed and careful medical treatment for at least a week before the operation, which may be a difficult and prolonged one. The ideal is to excise the ulcer, provide free drainage of the stomach, and restore as far as possible the normal anatomical and physiological conditions. The preliminary radiographic examination may have shown that nearly all the food leaves the stomach through the pylorus, and at the operation the pylorus and duodenum may be found to be patent, any previously existing ulceration having healed without causing obstruction. Under these circumstances the gastro-jejunostomy should be abolished, the ulcer excised, and the opening in the jejunum closed without narrowing its channel. This should also be done when the primary operation was improperly performed for gastric symptoms without structural alteration of the stomach or duodenum. Any operation that adds further anatomical or physiological complications is to be avoided. The addition, for instance, of another gastro-jejunostomy, in the hope that freer drainage of the stomach may induce the ulcer to heal, is doomed to failure. It is far better to excise the ulcer, although this may prove more difficult and dangerous, especially when the gastro-jejunostomy is of the posterior type.

The operation should commence as a rapid exploration of the abdomen, and any primary source of infection which may be discovered, such as a diseased appendix or gall-bladder, should be removed. The stomach, duodenum and the stoma should be carefully examined for signs of ulceration and obstruction. Dense adhesions may make this preliminary step difficult, and it is easy to overlook a small ulcer, especially on the posterior surface of the stoma.

The stoma is often narrow and sometimes very small. Occasionally it is normal in size but the jejunum is kinked or twisted by adhesions, so that the food, which has been shown by the x-rays to leave the stomach in a normal manner, does not pass freely along the jejunum. When the ulcer has been found, the adhesions should be separated or divided, and the parts carefully freed, identified and brought forward into the wound. This important step is often tedious and difficult, especially when the ulcer is posterior and invading the pancreas. Division of the posterior parietal peritoneum greatly facilitates the

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mobilisation, but some of the invaded pancreas may have to be removed with the ulcer. A rubber cushion behind the back helps to bring forward the lumbar spine and makes the dissection easier.

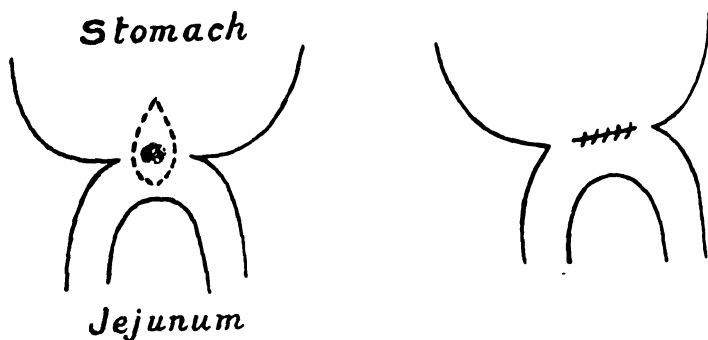


FIG. 4.

Excision of a localised ulcer on the front of the stoma; an elliptical incision is made, and this is sewn in such a manner as to enlarge the stoma.

Having separated and brought forward the parts concerned in the anastomosis, the most suitable treatment is more easily decided.

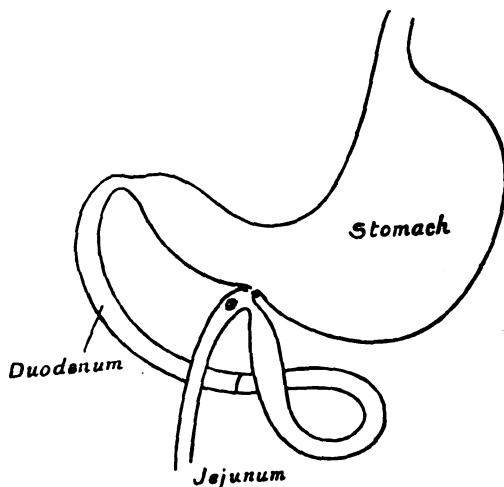


FIG. 5.

Jejunal and gastro-jejunal ulceration four years after anterior gastro-jejunostomy for duodenal ulcer; the pylorus was stenosed and adherent. The ulcers were excised (*vide* Fig. 6).

(a) If the ulcer is small and not encircling the stoma, it is often possible to excise it and to sew up the resulting wound in such a way as to enlarge the stoma or jejunal channel (Fig. 4).

(b) If the ulcer is large or encircles the stoma, which is often contracted, it is necessary to excise the ulcerated area, thus detaching the jejunum from the stomach. A more perfect gastro-jejunostomy can then, if necessary, be performed.

(c) If the pylorus and duodenum are healthy and patent, as occasionally happens, it is not necessary to re-make the gastro-jejunostomy; it is better to close the opening in the stomach and the jejunum, thus re-establishing the normal anatomy and physiology of the parts.

(d) If the original gastro-jejunostomy was anterior, it is sometimes possible to perform gastro-duodenostomy, making

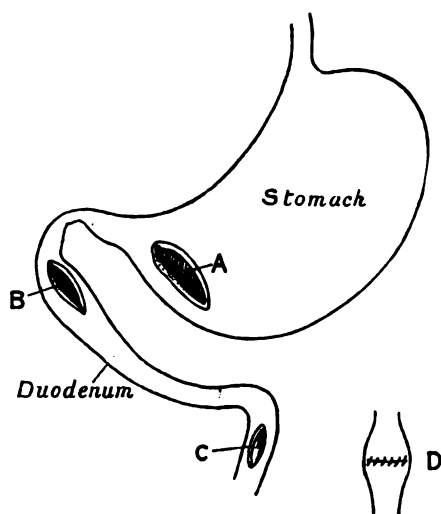


FIG. 6.

Same case as Fig. 5. The circumferential and jejunal ulcers were excised, and the gastric opening thus left at A was joined to the front of the second part of the duodenum at B. The large jejunal opening C was closed as shown at D. Catgut was used throughout.

use of the opening left in the anterior wall of the stomach after excision of the ulcer (Figs. 5 and 6). The opening in the jejunum is then closed without narrowing the lumen. The result in a case operated on by one of us (R. P. R.) has remained very satisfactory for ten years. After this operation recurrence of ulceration at the stoma is very unlikely owing to the free admixture of the alkaline duodenal secretions with the gastric juice.

(e) When the pylorus is stenosed, Finney's operation of pyloroplasty has been performed for similar reasons, the ulcer being excised and the openings in the stomach and jejunum closed (Fig. 7).

(f) Sometimes a gastro-jejunal ulcer may be approached and excised by making an opening in the anterior wall of the

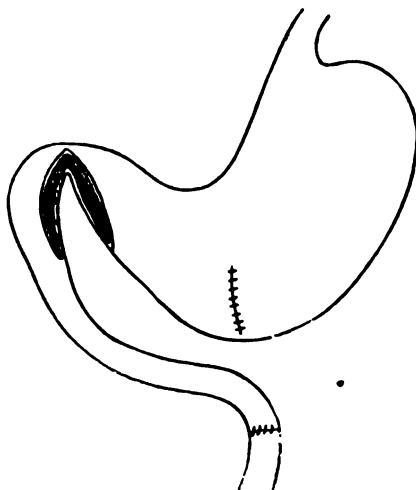


FIG. 7.

Abolition of the gastro-jejunostomy, excision of the gastro-jejunal ulcer, and correction of pyloric stenosis by Finney's operation.

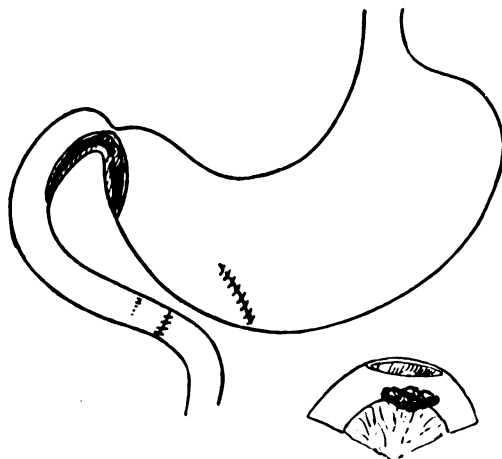


FIG. 8.

When there is extensive ulceration, especially at the mesenteric border of the jejunum engaged in the anastomosis, the diseased part of the jejunum is excised, an end to end or end to side union made, and the gastric opening is closed. The pylorus, if stenosed, is enlarged by Finney's method.

stomach. So far we have not considered this worth doing in any of our cases, for it is generally necessary to enlarge or re-arrange the stoma or jejunal loop.

(g) If the ulcer is large and on the mesenteric border of the

part of the jejunum engaged in the anastomosis, it may be necessary to excise the length of the jejunum thus engaged and to make a new gastro-jejunostomy after Roux's method, but recurrence of ulceration at the stoma is likely and actually happened in a case reported by Moynihan.⁶ It is therefore

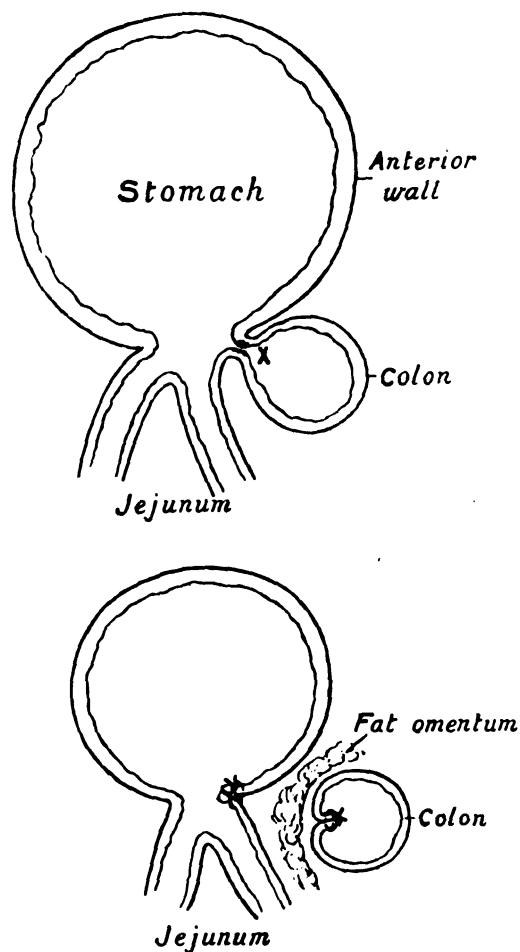


FIG. 9.

Sections of stomach, jejunum and colon, showing treatment of gastro-jejuno-colic fistula. The fistula at X is excised, the stoma enlarged, the colon closed and separated from the stomach by omentum.

better to abolish the gastro-jejunostomy, enlarge the pylorus, if necessary, and restore the channel of the jejunum (Fig. 8).

(h) Partial gastrectomy has been recommended and performed in the vain hope that ulceration would not recur. This operation is unsound in theory and too severe and dangerous in practice.

The operation mortality in Eustermann's 84 cases from the Mayo Clinic was 4 per cent., and only about 30 per cent. were cured or greatly improved, so that the results of surgical treatment cannot be regarded as very satisfactory.

(3) *Gastro-jejuno-colic fistula.* When the ulcer has perforated into the colon, early surgical treatment is imperative, but it is beset with difficulties, and the general condition of the patient is often very bad. Under these circumstances it is tempting to perform another gastro-jejunostomy, in the hope that the free drainage of the stomach thus provided may allow the ulcer to heal, but experience shows that this plan is not likely to succeed. The only satisfactory treatment is to separate the colon, close the opening in it, and then excise the ulcer and enlarge the gastro-jejunostomy opening (Fig. 9). This has proved entirely satisfactory in one of our patients, who has remained well for over five years. Our other two patients died; in one case an anterior gastro-jejunostomy failed to give any relief; in the other the ulcer had opened into the colon and ileum, kinking the latter and causing intestinal obstruction which was relieved by entero-anastomosis, but wasting continued and the man died about three weeks after this operation. We are convinced that the radical operation of excision of the ulcer and detachment of the colon is the only operation that is likely to succeed in these desperate cases.

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NOTE ON HOUR-GLASS CONSTRICTION OF THE STOMACH DUE TO PRESSURE BY THE SPLENIC FLEXURE DISTENDED WITH GAS

By P. BRIGGS, M.A., Radiographer to New Lodge Clinic, Windsor Forest.

THE last issue of the *Guy's Hospital Reports* contains a paper on Hour-Glass Constriction of the Stomach by Dr. Hurst and Mr. Rowlands, in which it was stated that a partial hour-glass constriction may result from pressure exerted by gas in the colon at the splenic flexure. This condition can be easily recognised radiographically, the stages to be seen varying with

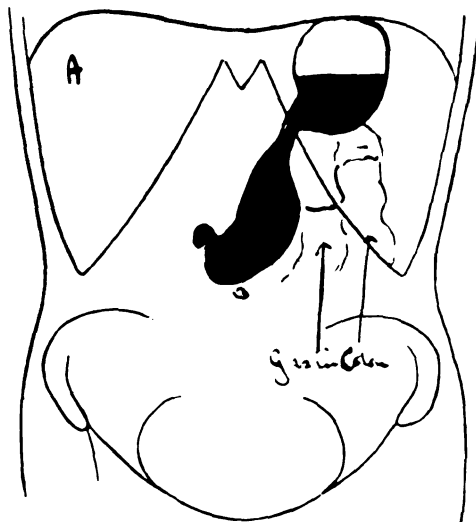


FIG. 1.

the degree to which the colon is distended from a small indentation along the greater curvature to a complete hour-glass constriction. The two following cases, which demonstrate this condition, may be of interest. The patients were both women, and in neither case did the stomach regain its normal contour when the patient was placed in the horizontal position.

Case 1 (Fig. 1) showed a well-marked mid-gastric constriction in the erect position, with the usual blunt end to the lower pole of the upper segment of the stomach—the opaque meal flowed freely from the upper to the lower segment.

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Tenderness on palpation was localised to the colon and there were no signs to suggest the presence of gastric ulcer. Three days later the patient was re-examined and showed a capacious atonic stomach with no trace of the constriction and no evidence of gas in the colon.

In Case 2 (Fig. 2) the mid-gastric constriction was even narrower than in Case 1, the passage of opaque fluid between

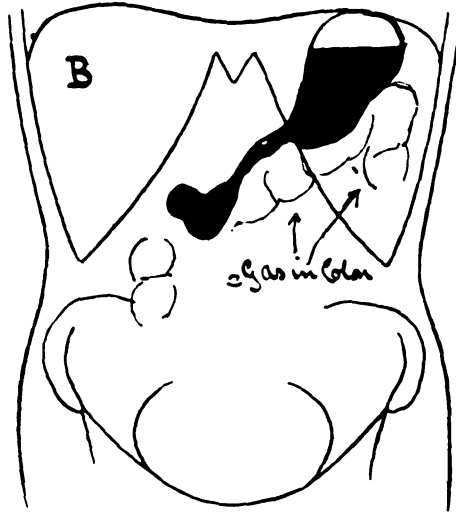


FIG. 2.

the upper and lower segment being very slow. Moreover, the lower segment was pushed across the mid-line of the body to the right side by the distended splenic flexure, the gas in which was clearly visible with the x-rays.

The abdomen was opened for a suspected lesion in the intestine. The stomach was found to be normal in outline, with no evidence of hour-glass formation. The colon was dilated and atonic, owing to incomplete obstruction by adhesions in the pelvis.

NOTES ON A CONSECUTIVE SERIES OF 458 CASES OF FRACTURE OF THE UPPER LIMB TREATED AS OUT-PATIENTS

By E. G. SLESINGER, O.B.E., M.S., Assistant Surgeon, and Surgeon in Charge
of the Fracture Department, Guy's Hospital.

THE Fracture Department, at which all cases of recent fractures in out-patients are treated, and which, so far as I can ascertain, is unique, at any rate in London, offers unrivalled opportunities for a study of the mechanics, prognosis and treatment of such simple fractures as can be treated by conservative means. It has in consequence been felt that a summary from time to time of certain groups of cases may be of interest and throw light on the success or otherwise of certain forms of treatment. These patients on their first attendance are treated, and excellently treated, at the Surgery, but a knowledge of the methods used in the Fracture Department may secure a greater uniformity in this early treatment.

For the purposes of the present paper a consecutive series of 730 patients attending the Department during the last eight months of 1920 has been taken. In each case the diagnosis was based on the x-ray plates of the case, and in nearly all the cases where the functional result was less than 100 per cent., the condition was verified by further x-ray examination.

Of this series of 730 patients there were 458 cases of fracture of the upper limb, or 62·6 per cent., and it is proposed to deal with these alone in the present paper. This percentage is undoubtedly not a true one as regards the liability to fracture in the upper and lower limbs, in that, firstly, a much larger proportion of lower limb fractures are admitted directly to the wards, and, secondly, more patients with lower limb fractures remain at home in bed under the care of their own doctor.

Of the 458 cases 303 were males and 155 females, a proportion of almost 2 to 1, and this fact must be borne in mind when considering the sex incidence of certain groups of fractures to be discussed later.

In a number of cases admission with a view to opera-

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tion was advised on the first visit, and these of course have not been included. On the other hand, in a few cases failure of treatment necessitated late operation, such cases being included and discussed in their appropriate place. It becomes increasingly obvious with experience of a larger number of cases that there are certain types of displacement in certain groups of fractures, which call inevitably for open operation, and in which there is nothing to be gained by any attempt at conservative treatment, and this is even more markedly the case in the lower limb. In certain other cases operation is sometimes needed as the result of the failure of conservative measures. The object to be aimed at in the future must therefore be to eliminate the latter group, which should not really occur at all, and to secure general agreement on the first group, so that what is a comparatively simple operation on a recent case, may not be turned into a difficult one on a malunited case by fruitless and misguided attempts at conservative treatment.

It is of interest to note that there was no case of non-union of a fracture in this series.

FRACTURE OF THE ACROMION PROCESS

It is a singular fact that in this series there was only one example of this fracture, a fact which can only be explained on the assumption that this injury is frequently overlooked, as it is by no means uncommon in the ordinary surgical Out-patients' Department to see patients presenting obvious evidence of an old fracture in this region, who are unaware of ever having sustained a fracture at the time of their original injury.

FRACTURE OF THE CLAVICLE

There were 77 cases of fracture of the clavicle, or 16·8 per cent. of the upper limb fractures, and of these 14 were greenstick fractures. The age distribution of these cases is interesting in that no less than 79 per cent. were under 20 years of age. The cases occurred as follows :—

Under 10 years.	From 10 to 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	From 70 to 80.
47 cases	13 cases	3 cases	1 case	7 cases	1 case	2 cases	3 cases

Of these 77 cases, 46 were males and 31 females, indicating that females are more prone to suffer from this injury than would be expected from the normal sex ratio of all upper limb fractures. The site of fracture was almost invariably in one of two situa-

tions, either the outer third of the bone from direct violence with the typical downward and forward displacement of the outer fragment, or of the middle third of the bone as the result of "indirect" violence.

The usual description in surgical textbooks of this latter fracture is that it occurs at the junction of the two curves in the bone. This I believe to be incorrect in fact, as well as being mechanically unlikely; the usual situation of this fracture in our experience is well within the anterior concavity. The displacement is fairly constant; the fractured ends are displaced upwards and forwards, the shoulder and with it the outer fragment is dropped and displaced forwards, and the outer end of the inner fragment usually overlaps the outer fragment. This displacement is usually described as being brought about by muscular action, a statement constantly made in reference to displacement in fractures, and for which I would maintain there is in the majority of cases not the least evidence. There can, I think, be little reasonable doubt that the displacing force in a fracture is the force which causes the fracture, and every evidence points to the action of muscles as being quite negligible in this respect. To know the mechanism by which a particular fracture is produced is to know the displacement, and the degree of such displacement will vary with the fracturing force and the mechanical advantage at which it acts.

In regard to the so-called indirect violence fracture of the clavicle, it is usually stated that by a fall on the shoulder or the out-stretched arm, force is transmitted along the clavicle and fractures it at its weakest part. So long ago as 1885 it was pointed out by Sir Arbuthnot Lane in the *Guy's Hospital Reports* that when the shoulder passes backwards, the clavicle impinges on the first rib, and that owing to the oblique position of the first rib varying points on the clavicle meet it, according to the direction of the force applied to the shoulder. When the shoulder is driven violently backwards and upwards by a fall on the out-stretched arm, it happens occasionally that the first rib is fractured, or more rarely still that the sterno-clavicular joint is dislocated. Much more frequently, however, it is the clavicle which gives way, being broken across the first rib, much as one breaks a stick across the knee. This I believe to be the common mechanism in this type of fracture, and it accounts for the constancy of the type of displacement, the overlapping of the fragments being brought about by the elastic recoil of the shoulder from its position of hyper-extension.

The treatment of these cases is very satisfactory, and though in some cases the anatomical result may not be by any means

perfect, the functional result almost invariably is. Such a statement is not possible of the majority of fractures, where as a rule the only certain way to ensure a perfect functional result is to secure a perfect anatomical reposition. In the case of the clavicle, however, the muscles are not acting along an axis parallel to its length, and consequently small alterations in its length or curves are not of such great importance as in the case of other bones.

For the treatment of the direct violence fractures of the outer end of the bone, some form of Sayre's method is very effective, the essential feature being the adequate support of the elbow. In the fractures of the middle third, particularly in children, all that is usually needed is some method of drawing the shoulders well back. Two well-fitting loops of strong material over the point of the shoulders, drawn well together behind by a strong connecting band, serve the purpose admirably, and this method avoids the damage which strapping so often causes to the skin in children. These "braces" are kept on for two weeks, after which a sling for a further week is sufficient. All these cases secured a perfect functional result, and were under treatment for an average time of three weeks.

FRACTURES OF THE HUMERUS

This bone was fractured in 70 cases, including separations of the epiphyses, making 15·2 per cent. of upper limb cases. This does not represent all the cases seen, as a considerable number of fractures of this bone required admission for operative treatment. In a large proportion of fractures of the shaft of the humerus, one or other fragment becomes imbedded in the surrounding muscles, and the result to be obtained from manipulative reduction is so imperfect that open operation appears to be far better. Further, in fractures through the region of the musculo-spiral groove, whether the nerve is damaged at the time or not, operation, with possibly transplantation of the nerve, is usually advisable. Again, certain separations of either epiphysis require operation, as will be pointed out later, and the same is true in regard to all T-shaped fractures into the joint at the lower end, so that quite a proportion of the cases where the humerus is fractured pass out of the scope of non-operative treatment.

FRACTURES OF UPPER END OF THE HUMERUS

There were 19 cases in this group.

(a) *Fracture of the surgical neck.*—There were thirteen cases of this injury, of which two were associated with a dislocation of

the shoulder joint. Eight were males and seven females, and the average age of occurrence was 51 years. In eleven cases the fracture was impacted. The mechanism of this fracture was the same in all the cases except one, being a direct fall on the point of the shoulder, presumably fracturing the bone against the glenoid cavity by leverage. In one case the fall was on to the hands and the mode of fracture is obscure. In the two cases with dislocation the impaction was sufficiently firm to permit of easy reduction.

The method of treating these cases has unfortunately so far had to be a compromise. As has been pointed out elsewhere * in reference to compound fractures, *the proper position for all cases of fracture in the upper limb is one in which all the gravity-opposing muscles are kept short at the expense of their gravity-aided opponents.* The anti-gravity movements of the upper limb are abduction and elevation at the shoulder joint, flexion at the elbow, supination in the forearm, dorsiflexion at the wrist and separation of the fingers. If the muscles performing these movements are kept short during the period of repair of the injury, the opposite movements will be readily restored on releasing the limb, by the action of gravity, aided if need be by simply giving the patient a weight attached to the hand to carry. It is the neglect of this simple principle in the treatment of fractures which leads to many of the bad results so commonly seen, it being almost invariably the anti-gravity movements which are deficient. Such deficiencies are most difficult to correct, whereas any lack of gravity-aided movements can be readily overcome by increasing the gravity effect by means of a weight. On this principle fractures of the upper end of the humerus should be treated by putting the arm in a position of extreme abduction and elevation at the shoulder joint, a position easily obtained in bed with the suspension-extension splint, but difficult in an ambulatory case. In the present cases, impaction, when present, was left alone and they were treated with a Stromeyer's cushion in the axilla for two to three weeks, followed by massage and active and passive movements, this being one of the few fractures in which passive movement is necessary. The average time under treatment was 6·8 weeks. The results were only fair; seven cases had a perfect result and in the remaining six abduction was limited. These included the two cases complicated by dislocation. It is difficult in these cases to know whether or not injury to the circumflex nerve contributes to the deficient abduction, but such an injury must be very common. These patients are apt to develop adhesions within the shoulder-

* E. G. Slesinger, *Lancet*, 1919.

joint, characterised clinically by a spot of extreme tenderness over the upper end of the bicipital groove. Manipulation of the joint through its full range of movement under gas-oxygen anæsthesia usually suffices to cure the condition, although the manipulation may need repeating on two or three occasions. Mr. A. H. Todd has recently devised an ambulatory abduction arm splint, which should prove very useful for these often very troublesome cases.

(b) *Fracture of the greater tuberosity.*—There were 5 cases, 3 female and 2 male, the average age being 52 years, and two of the cases were complicated by a dislocation at the shoulder-joints. In three of these cases operation was advised but refused, and in the other two the displacement was comparatively slight. One of these patients did not return after her first treatment and could not be traced. These patients were treated in the same way as fractures of the surgical neck of the bone, and the result was perfect in two cases, one was lost sight of, and the remaining two, who should have been operated on, showed considerable limitation of rotation and abduction at the shoulder joint. The average time these patients were under treatment was nine weeks.

(c) *Separation of the upper epiphysis.*—There was only one case of this injury and in that the displacement was small. It was treated by immediate mobilisation with an excellent result. The mechanism of this injury is similar to that of fracture of the surgical neck in the older patients. In many cases the epiphysis rotates, in which case operation for its replacement is essential.

FRACTURE OF THE SHAFT OF THE HUMERUS

A number of these cases were advised and accepted admission, only 7 being treated as out-patients. Of these, three, aged 90, 70 and 69, were so treated on account of age, one was a birth fracture, one was five months old and one seven years, while one, a woman of thirty-eight, with outward displacement, was found to reduce very readily. In the children an external cardboard splint was used, and in the adults a Middeldorpf triangle with weight extension at the elbow. In all the results were excellent.

FRACTURE OF THE LOWER END OF THE HUMERUS

There were 7 cases, 5 male, 2 female. Four cases were *fractures of the internal epicondyle*, the average age being 44. They were treated by mobilisation and massage and all recovered fully in four weeks, there being no evidence of trouble with the

ulna nerve. It remains to be seen whether late involvement of the ulnar nerve is liable to occur or not.

Fracture of the external condyle occurred in one case only, and was treated for a period in full supination and partial flexion, followed by massage. This case proved troublesome, but was restored to full function in ten weeks. There were two cases of *fracture of the capitellum*, both caused by a fall on the hand with the elbow flexed. They were treated in full flexion, one with a perfect result and one with some small limitation of full extension.

Separated lower humeral epiphysis, or more correctly metaphyseal fracture of the lower end of the humerus, occurred in 37 cases, or 8 per cent.; of which 27 were males and 10 females. The average age of the cases was 7·5 years.

The history of the accident in many of these cases is vague, but the majority in whom a story could be obtained described a fall on to the elbow, or hand. The usual displacement is that the epiphysis passes backward and is rotated backwards and is displaced either to the inner or outer side, more commonly the former. Occasional forward displacement of the epiphysis is met with, such cases usually requiring operative reposition. It is most important that this injury should be treated quite soon after the accident, as, later, swelling makes reposition difficult. Where the amount of actual rotation of the epiphysis is very marked, it is usually not possible to restore position by mere manipulation, and reposition through an open incision becomes necessary. Careful examination of the whole arm in these cases is most essential, as injuries of the ulnar nerve at the time of accident occur every now and then, and it is disconcerting to discover an unsuspected ulnar lesion for the first time on taking down the arm. In the treatment of these cases the Robert Jones flexion position gives very good results, in that it carries out the principle of keeping the anti-gravity muscles, namely the flexors of the elbow and the supinations, short at the expense of the gravity-aided muscles. At the same time, in putting up these cases it is not sufficient merely to correct the backward displacement and rotation by flexion, but at the same time any inward or outward displacement must be reduced by direct pressure on the fragment, as otherwise cubitus varus or valgus is liable to follow during growth of the limb. The period during which flexion should be maintained is largely a matter of opinion, and in the Fracture Department we have been cutting down the time with no ill-effects. American surgeons state that early mobilisation tends to the production of callus, but our experience would point in the opposite direction. It may

be taken as a law that the amount of callus thrown out round any fracture varies directly with the degree of anatomical malposition of the fragments after reduction. Further, since there can be little doubt that the displacing force in nearly all upper limb fractures is the fracturing force and not the pull of muscles, all that is required is to reduce the displacement accurately, and keep it reduced just long enough to prevent the weight of the arm, or its leverage through ligaments, from reproducing it. In the cases we are now dealing with our present method is to put them up in full flexion and supination for two weeks, and at the end of that time to begin massage and active movement, resting the arm in between in a sling. If at the end of a week of this treatment full active extension is not obtained, the sling is discarded, and a weight of 1 lb. to 3 lb., depending on the age, is fixed to the hand and carried about for an additional week or fortnight. This method almost invariably restores full extension if the original replacement was satisfactory. In a few cases, however, a spasm of the biceps persists, followed apparently by actual shortening of the muscle. Such a condition is usually overcome by increasing the weight, but in one case in this series, and in a further case since, it was necessary to do a lengthening of the biceps tendon, an operation readily performed under local anæsthesia. The average time of treatment of the present 87 cases was 4·7 weeks, the larger number being restored to full movement in less than 4 weeks.

In the present series there were two cases with an anterior displacement of the lower fragment, and these were treated in full extension and supination. One recovered completely, and the other had 15° limitation of flexion. Of the remaining 85 cases, 81 obtained full range of normal movement, one of the remaining four did so after lengthening of the biceps tendon. The remaining three had some limitation of movement, one of extension only, beyond 145°, while the other two had a range between about seven minutes and twenty minutes. These no doubt will improve further in time.

In this particular series there was no case of involvement of the ulnar nerve, but there have been cases before and since.

FRACTURES OF THE RADIUS ONLY

This bone constitutes by far the commonest site of fracture in the present group of cases. It was fractured alone in 151 cases, while including cases of fracture of both radius and ulna it was the bone fractured in no less than 234 cases, or over 50 per cent. of the series. The fractures to which the radius is liable are singularly well defined as they actually occur, although

in the textbooks a variety of types of injury are described which do not appear to occur, at any rate except as extreme rarities in practice.

FRACTURES OF THE HEAD AND NECK OF THE RADIUS

There were 11 cases, 6 males and 5 females, and the average age at which this injury occurs is represented by 24·7 years, although there were 2 cases in children and one in old age.

Two distinct types of injury occur at this portion of the bone. The first is a vertical fracture through the head, either at the middle or at the margin, in which there is usually little displacement. The mechanism seems to be a fall on the hand with the elbow flexed, or, in other words, an impaction fracture against the capitellum. There were six cases of this type, which were treated by a high flexion sling and immediate massage. In five cases there was a perfect result, and in one flexion and supination were full, but extension was limited to 160°.

The second type of injury is more serious and consists of a fracture through the neck of the radius, often with considerable displacement of the head. If this displacement is marked it would seem to be the best treatment not to attempt conservative measures, but to remove the fractured head forthwith.

If the displacement is not so marked, full flexion and supination as for separated humeral epiphysis gives fair results. There were five cases of this type treated, and though the mode of fracture was not very clear it seemed to be associated with hyperextension of the elbow. Of the five cases treated four had a perfect result, while in one flexion and extension could only be carried out from 10 minutes to 25 minutes. This case would have undoubtedly been better treated by removal of the upper fragment originally.

FRACTURE OF THE SHAFT OF THE RADIUS

(a) *Greenstick fracture* occurred in 13 patients, 11 males and 2 females, illustrating the greater liability of the male to fracture in early life, whereas the female becomes more liable in old age. The average age of the patients was 9·2 years. In connection with this figure it is interesting to note that the average age for a greenstick of the ulna alone is 6 years, for a greenstick of both radius and ulna 7·9 years and for a greenstick of the radius only 9·2 years, indicating apparently an earlier hardening of the cortex of the ulna than of the radius. The treatment in these cases was to restore the normal contour of the bone, either with

or without an anæsthetic, and then the arm was usually put up in full supination on an anterior angular splint for a week, after which active movement was allowed. In all these cases a 100 per cent. result was obtained, average time of treatment being 2·8 weeks.

(b) *Fracture of the shaft.* It is usual to divide these fractures according to their relationship to the insertion of pronator radii teres, but practically the only object of such a division was a supposed difference in the displacement and in the treatment, for neither of which does there appear to be any adequate justification.

There were 8 cases of fracture of the middle two-thirds of the shaft of the radius, 4 males and 4 females, the average age being 27·5 years. One or two cases of this fracture in which the displacement could not be adequately corrected were admitted to hospital, as proper restoration of alignment is essential to good function in this bone. The mechanism of this injury is almost always direct violence. These cases were treated in full supination, usually on an anterior angular splint, with a pad to correct any tendency to backward bowing which frequently exists. At the end of two weeks a sling is sufficient and massage and active movement can be begun. In all these 8 cases a 100 per cent. return of function was secured.

FRACTURES OF THE LOWER END OF THE RADIUS ALONE

In this region of the bone four types of fracture occur, namely (a) Colles' fracture, (b) fractures of the lower quarter of the shaft, (c) separation of the lower epiphysis, and (d) fracture of the base of the styloid, or "back fire" fracture.

(a) *Colles' fracture.*—There were 73 cases of this fracture, or 15·9 per cent. of fracture of the upper limb, of which 47 were in women and 26 in men, a marked preponderance in women amounting to almost four times the normal liability. The ages of these patients were interesting in that the average age in women, 53·2 years, is considerably higher than that in the men, namely 42 years.

The age distribution was as follows, showing a much more typical incidence in the women than in the men :—

	Cases under 20 years.	Between 20 and 30.	Between 30 and 40.	Between 40 and 50.	Between 50 and 60.	Between 60 and 70.	Between 70 and 80.
Women . .	0	1	3	10	20	9	4
Men . . .	1	5	3	9	4	3	0

This does not include quite all the cases of this type of injury,

as where the violence is extreme the radial abduction is sometimes sufficient to tear off in addition the styloid process of the ulna. Eight examples of the more severe type occurred, and will be discussed under fractures of both bones.

The mechanism of Colles' fracture is almost invariably a fall on to the hand, the fracture being produced partly by hyperextension of the wrist, and partly by direct violence to the lower end of the radius. The displacement of the lower fragment is constant in type but varying in degree, and impaction is common.

The lower fragment may be displaced and rotated backwards, displaced and rotated radially, and bodily displaced upwards, and any combination of these deformities may occur. Backward rotation and displacement are the commonest, and radial rotation is common, but actual radial displacement only occurs occasionally in our experience. These cases should be treated very soon after the accident, and if there is any real displacement an anæsthetic is essential. In hospital, where some of these patients are very old and frail, it is occasionally necessary to temporise with the case without anæsthesia, owing to the reluctance of some of the patients and the undesirability of giving anæsthetics to such frail old people under out-patient conditions. When, however, an anæsthetic can be given, I believe it is always possible to reduce these fractures accurately, provided they are seen within the first few days after the accident. In some cases, where there is much comminution, it may be impossible completely to restore the normal contour, but the backward displacement and rotation which are the most important can always be overcome. The usual method of grasping the patient's hand as in a handshake is often insufficient for reduction. With the forearm fixed on one bar of a rectangular splint, having its right angle opposite the wrist joint, the lower fragment must be forcibly manipulated until not only is the normal form restored, but complete flexion of the wrist to a right angle is possible, which it will not be unless reduction is complete. After trying various methods of treatment, we have now adopted one which appears to give the best results, and also reduces the time under treatment considerably. This method is, of course, only used when the displacement is sufficient to warrant it. The fracture is reduced over a rectangular splint, well padded, and is then fixed on the splint by two strips of strapping so that the wrist is flexed to a right angle. One strip passes round the lower forearm and the splint, and the other round the hand and the other arm of the splint. This position is maintained for forty-eight hours, after

which the splint is removed and gentle massage given. There is no tendency to redisplacement after this period except in very comminuted cases, when a longer time is necessary. After massage the forearm is put on a slightly cock-up splint, with a tennis ball in the palm of the hand. This restores the palmar arches, prevents flattening, and obviates the stiff fingers which are so apt to occur. The patient is encouraged to grip the ball and attends for daily massage. Except in comminuted cases they are given a whirlpool bath before massage, a treatment which appears remarkably efficient. The principle of the whirlpool bath is a bath of comfortably hot, rapidly moving and freely aerated water, and it produces a hyperæmia more intense and more rapid than anything else with which I am acquainted. Its value, particularly as applied in the massage department, immediately preceding the massage, and under highly skilled supervision, cannot be over-estimated for these cases. On the tenth day all splints are removed, and active movements are encouraged, and at the same time passive finger movements can be begun. A sling is usually worn for another week. I believe it is of considerable value to put these elderly patients on a course of thyroid extract at the time of the injury, as by increasing metabolism and repair it tends to prevent the troublesome traumatic arthritis so liable to follow this injury.

The average length of treatment in the 47 female cases was 5·9 weeks, the longest being 24 weeks, and in the 26 males the average time was 4·5 weeks, the longest being 12 weeks.

Of these 73 cases 8 discontinued attendance before treatment was finished, but from our experience of these patients it seems safe to assume their result was all that they desired. Four cases had very considerable limitation of flexion, one of whom had refused to allow reduction; seven others had limitation of flexion, but not enough to interfere seriously with function; two had persistent œdema and pain, and these two were women of 63 and 67 who were really seriously crippled as a result of their accident. One patient had a persistent and marked radial deflection due to imperfect reduction.

The remaining cases, though a few showed slight differences in range of movement as compared with the other hand, could be considered to be functionally adequately restored. Therefore, eliminating the 8 cases who discontinued, there remain 65 cases, of whom 7 were serious failures (one through her own refusal of reduction), 7 were approximately restored to 75 per cent. of normal function, and the remainder, while not all perfect, had perfectly satisfactory wrists.

(b) *Fracture of the Lower Quarter of the Shaft.*—There were 21 of these cases, fifteen males and six females, the average age of occurrence being 29. Fractures in this region are of various types and hard to classify. Nine cases represented cracks through to the articular surface, with very little displacement. They can be actively treated from the first by massage and whirlpool baths, but during the first week they should be rested between treatments on a cock-up splint. All these patients got a perfect result.

The remaining twelve cases of this group represented more severe types of injury, often with considerable displacement. The line of fracture is varying, but tends to run from above downwards and backwards, sometimes into the joint and sometimes not. The lower fragment is apt to be displaced forwards. Of these cases one was so unsatisfactory after a week's treatment that he was admitted to the wards. The remaining eleven were reduced, usually with an anæsthetic, and put up either on a cock-up splint, or on an anterior gutter of plaster moulded on to the forearm and hand at the time of reduction. After two to three weeks, whirlpool baths and massage were begun, the average time of treatment being 4.2 weeks. Of the eleven cases, nine had a perfect result, and two had slightly limited power of dorsiflexion.

(c) *Separation of the Lower Epiphysis of Radius.*—This, as in the case of the humerus, is in reality a metaphyseal fracture, but is not such a severe injury as in the case of that bone.

There were 20 cases, 18 males and 2 females, and the average age was 12 years, considerably older than in the case of the humerus. The mechanism of this injury is almost always the same as that of Colles' fracture in the elderly, and, like it, if the fracturing force is unduly severe, it is prone to be associated with a separation of the styloid process of the ulna. There were 6 cases of this complication which will be considered under the fractures of both bones. The displacement is often considerable, but produces a deformity somewhat dissimilar to the "dinner fork" appearance of Colles' fracture, in that the angles are far sharper. The usual displacement is backward of the lower fragment, with some backward rotation, but radial displacement or rotation is very unusual. Impaction does not occur, and though the lower fragment is sometimes compressed, it is not apt to be comminuted as in the older type of patient. Reduction is consequently easy as a rule, and the tendency to redisplacement extremely small if further falls are prevented. A number of these cases were reduced and treated straight

away by a sling only, active movement being encouraged at once. The cases with more soft tissue damage were put up for a few days in extreme flexion of the wrist, either on an anterior rectangular splint, or on an anterior plaster mould, before instituting massage and movement. Of these 20 cases, one went to the country before treatment was finished, and one unusual case, with considerable radial displacement of the lower fragment, was not completely reduced; the remainder had complete restoration of function and position. It must be remembered that in injuries to the epiphysis, it is even more essential to secure perfect anatomical reposition than in other fractures, as comparatively small displacements lead to troublesome deformities as growth occurs. The average period of treatment of these cases was three weeks.

(d) *Fracture of the Styloid Process at its Base, or "Back-fire" Fracture.*—This injury is not that usually described as chauffeur's fracture, which represents the cases under the second division of section (b) above. It is a fracture which is invariably produced by a back-fire when starting an engine, or by a similar accident, causing a sudden sharp blow against the thenar eminence. There were 5 cases in the present series, and there have been a number before and since, and the fracture is singularly constant in position. Of the present 5 cases, 3 were in males from a "back-fire," and 2 were in females from a fall on to the hand, striking the palm in the region of the thenar eminence. The fracture runs, from above and without, downwards and inwards on to the articular surface of the radius just internal to the styloid process, and the styloid process and the process of bone forming its base constitute the lower fragment. This fragment is usually only slightly displaced radially and upwards.

These cases were all treated by immediate massage, with whirlpool baths, and were rested in a sling between treatments. They all secured a perfect result, and were treated on an average for three weeks.

FRACTURES OF THE ULNA ALONE

The ulna was fractured alone in 27 cases in this series, and, including the cases of fracture of both bones, it was involved in 111 cases, or 24·2 per cent.

Fractures of the ulna alone may be divided into (a) fractures of the upper extremity of the bone, (b) fractures of the shaft, and (c) fractures of the styloid process.

(a) *Fractures of the upper end of the ulna* include both fractures

of the olecranon and coronoid processes. All complete fractures of the olecranon were at once admitted for operation, and only 4 cases, 2 male and 2 female, of incomplete fracture were kept for conservative treatment. In all these cases the fracture was subperiosteal, and the fragments were firmly held in position by the expansion of the triceps. They were treated by rest in a sling with immediate massage and whirlpool baths to promote union, and all secured a perfect result.

Fracture of the *coronoid process* occurred in 2 cases, both males. Though this fracture usually occurs as a complication of backward dislocation of the elbow, neither of the present two cases was associated with that injury. The mechanism in each case was a fall on the fully extended arm, and the fracture was determined rather than a dislocation, presumably by some local difference from the normal in either ligamentous or bony strength. These cases were treated in full flexion and supination, and both obtained perfect results in four weeks. There was no case of separation of the upper ulna epiphysis.

(b) *Fracture of the shaft of the ulna alone* occurred in 18 cases. Four of these cases were greenstick fractures, all in females, at an average age of 6 years. They were treated by straightening the bone and then encouraging active movements, and all did perfectly. Complete fracture occurred in 14 cases, 11 males and 3 females, the average age being 35 years. The mechanism in all cases was direct violence to the ulna, and in consequence the displacement varied with the direction of the blow, the most usual being a backward projection of the fractured ends. These cases were all easily reducible, but showed an irritating tendency to redisplacement owing to the elasticity of the bone. Those with any considerable displacement were therefore treated in plaster. They were put up in flexion and complete supination, as will be described under fractures of both bones, and maintained in plaster for from two to three weeks, after which massage and active movements were begun. All the cases obtained complete restoration of function, but the average time of treatment was six weeks, a period which should almost certainly be shorter.

(c) *Fracture of the styloid process*.—This injury occurs most commonly in conjunction with fracture of the lower end of the radius, complicating either Colles' fracture, or separation of the lower radial epiphysis. Including all these cases, fracture of the ulna styloid occurred in 17 cases. By itself it occurred 3 times, at the ages of 14, 24 and 25 years. The mechanism was in these cases indirect violence, namely extreme radial abduction of the wrist. In one case it was complicated by dislocation of

the semilunar bone. This latter injury was not recognised for two weeks, and the case was then admitted for excision of the semilunar owing to a stiff wrist. The remaining two cases were treated on a cock-up splint and by massage, and returned to work in 3·5 weeks fully restored. There was no case of separation of the lower epiphysis of the ulna.

FRACTURES OF BOTH RADIUS AND ULNA

Injuries to both these bones occurred in 88 cases, or 18·1 per cent. The fractures are most conveniently considered under four groups, namely (a) greenstick fractures, (b) complete fractures, (c) fractures of the lower ends of the Colles' type, and (d) fractures of the lower ends of the epiphyseal type.

(a) *Greenstick fracture of radius and ulna.*—This injury occurred in 35 cases, 28 being males and 7 females, a good example again of the greater liability of the male in early life. The average age of the patients was 7·9 years. These cases were all due to direct violence from falls on the forearm, and the fractures occurred in various parts of the bone, by far the commonest situation being the lower third of the shaft, and next commonest about the middle.

In the cases without much displacement, immediate active movement and massage were instituted, the arm being rested in between in a sling. Where displacement was marked, as it often was, the bones were straightened under anæsthesia, and a supination plaster, as described in the next section, was put on. This was left on for two weeks, when massage was begun. All these cases except one had a perfect result, the one patient having some limitation of supination. Average length of treatment was four weeks.

(b) *Complete fracture of radius and ulna.*—There were 34 cases in this group, 29 males and 5 females, and the age distribution showed a marked predisposition towards early life. The cases occurred as follows :—

Under 10 years.	Between 10 and 20.	Between 20 and 30.	Between 30 and 40.	Between 40 and 50.	Over 50 years.
7 cases	20 cases	1 case	2 cases	2 cases	2 cases

The mechanism in almost all these cases was by direct violence, but in some cases near the lower ends of the bones it seems as if they were produced by hyperextension of the wrist.

The position of the fracture varied considerably, perhaps the commonest site being at about the middle of the bones, and somewhat higher on the radius than the ulna. These fractures present the greatest difficulty of all upper limb cases in the decision as to whether open operation or non-operative treatment should be advised. It is most important that such a decision should be made early, as if union in a bad position is allowed to occur, the operation is very greatly increased in difficulty. In our experience these cases do very well provided they are treated in full supination, and a rough guide to the selection of cases for operation is to take those cases in which the bones cannot be manipulated into a good position in full supination. This is most apt to be the case in fractures of the upper third, where the tendency is for the fragments of the two bones to be involved in muscle. On the whole, these cases have given surprisingly good results, and the proportion requiring operation in the first place has been less than would have been expected. Of those kept for treatment only two required late operation for malunion, and one of these had fallen and refractured the bones during treatment. This patient showed well the fact that the fracturing force is also the displacing force, in that in the second case where the bony resistance was less the displacement was greater, although the fall in the second instance was, if anything, less severe. There can, I think, be no doubt in the mind of any one treating a number of these cases that the only way to secure good functional results, if there is any displacement, is to treat them in full supination. The constantly repeated advice in the textbooks that fractures below the insertion of pronator radii teres should be treated in the semi-prone position appears to be one of those pieces of bad advice which are invariably widely followed. As far as I can understand it, this advice is based upon the supposed position of the upper fragment; for some unfathomable reason it is considered necessary to make the lower fragment conform to this position. In the first place, in these cases the upper fragment is by no means always in a semi-prone position, though it very often is, but the main point is that it is in any case perfectly simple to put the upper fragment into full supination and to maintain it so in plaster.

If there has been any considerable displacement of fragments, these patients treated in the semi-prone position practically never regain full powers of supination, and it must be remembered that supination is a movement of far greater physiological importance than pronation.

All these cases have been treated with the elbow flexed to

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or just beyond a right angle, and in full supination, with slight dorsiflexion of the wrist, in other words in the full anti-gravity position of this part of the limb. The method used has been a plaster splint coming half-way up the arm and extending to just beyond the wrist (see Fig. 1).

A bar, suggested by Mr. A. H. Todd, has been incorporated in the plaster. This bar runs along the back of the splint on the radial side, passes behind the thumb, and runs up the front of the splint on the ulnar side. If the upper fragment is first

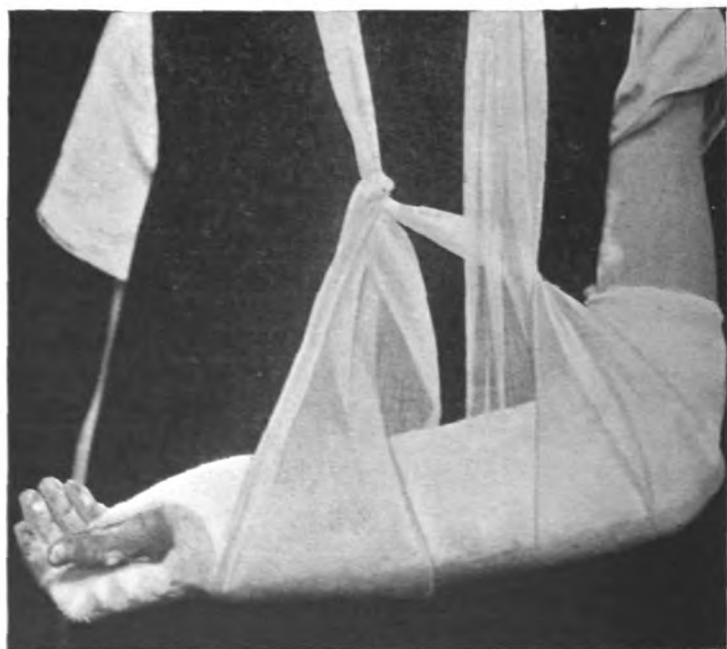


FIG. 1.

Supination plaster for fracture of radius and ulna.

firmly supinated and held so in plaster, and the lower part of the plaster is then put on, the bar maintains the position of supination excellently. A piece of rubber tubing threaded on the bar where it crosses the palm prevents friction, and by bending the bar any position of dorsiflexion of the wrist can be maintained.

This plaster is kept on for three weeks, and when it is taken off pronation is usually freely accomplished. If there is any stiffness massage and movements are given.

Two of the present series required operation. One, the patient above referred to, at the end of the treatment, for

malunion, and another one in whom x-ray examination through plaster showed the bones to be in bad position after attempted reduction.

Of the remaining 82 cases, one, a patient of 62 years of age, had some limitation of pronation, in three there was some angulation of the ulna, but the movements were full, and in the remainder the result was perfect. The average time under treatment was 6·8 weeks, though the majority were under that period. In no case did any complication of the fracture occur.

(c) *Fracture of the lower end of radius and styloid process of ulna. Colles' type.*—This fracture represents Colles' fracture occasioned by considerable violence, and occurring with the hand radially abducted. There were 8 cases, 6 male and 2 female. Considering the far greater liability of the female to Colles' fracture, this sex distribution probably is merely an indication of the greater liability of the male to the more violent forms of trauma as represented by this injury. The two women were considerably older than the men, but the average age of the group was 53·5 years.

In one case, not included in this series, the ulna styloid fragment was considerably displaced outwards, interfering with movement and necessitating operation for its removal. These cases were treated in the same way as Colles' fracture, excepting that in one or two the anterior drop splint was not used, a cock-up being employed from the beginning. They were kept in ulnar adduction while on the cock-up splint.

All these cases except one recovered fully. One had some limitation of flexion and supination, about three-quarters of normal. The average time under treatment was 6·2 weeks, somewhat longer than the cases of uncomplicated Colles' fracture.

(d) *Fracture of the lower end of radius and styloid process of ulna. Epiphyseal type.*—This injury consists of a metaphyseal fracture of the radius, with, in addition, a separation of the ulna styloid. It bears the same relationship to ordinary separated radial epiphysis as the fracture described under (c) does to Colles' fracture. In several of these cases the separated radial epiphysis is itself fractured.

There were 6 cases in this group, all males, the average age of the group being 16 years. These cases present the same mechanism and displacement, and were reduced in the same way as separated radial epiphysis only. They were kept splinted somewhat longer, and all obtained a perfect result. The average length of time under treatment was five weeks.

FRACTURES OF THE CARPUS. FRACTURED SCAPHOID

The only bone in the carpus of which a fracture occurred in the present series was the scaphoid, and this was the site of injury in 3 cases, 2 male and 1 female. It occurred in several other patients not in this series, being a far commoner injury than one would tend to believe. Where there is any considerable degree of displacement of the fragments, the result of conservative treatment seems to be almost invariably a very considerable degree of limitation of movement in the carpus, and these cases, since this fact became clear, have been admitted to hospital for excision of the bone. The results of this operation appear to be very satisfactory. The mechanism of this injury appears to be a fall on the abducted hand of the type which sometimes produces a vertical fracture of the lower end of the radius. The scaphoid appears to be fractured by the wedge-like action of the outer margin of the radius. Of the three patients in this group, the two males were treated by massage from the beginning and regained full function. The female patient was a bad epileptic, having several fits a day, who was continually reinjuring her hand during treatment. She eventually, after over five months' treatment, secured a satisfactory hand.

FRACTURES OF THE METACARPUS

There were 26 cases in which the metacarpal bones were fractured, 23 males and 3 females, a proportion which indicates the violent nature of this injury. In the treatment of these cases it is most important to bear in mind that the palm consists of two arches, a transverse arch, bony and ligamentous in nature, and a longitudinal one which is bony alone. When a metacarpal bone is fractured both these arches are disturbed, and, unless they are adequately restored during treatment, the condition of flat hand will result. Flat hand, though much less common than flat foot, is a very crippling condition, and one which, if it is once established, is most difficult to treat. The arches of the palm, curiously, are almost always an arc of the same circle, whatever the size of the hand. The size of the arc and not of its radius is the varying factor. This circle is very closely represented by a tennis ball, and a tennis ball fixed into the palm of the hand constitutes a splint which automatically reduces these fractures to the best functional position. Further, a tennis ball is just sufficiently resilient to permit of muscular contraction without movement during the early days of treatment. Its value in these cases cannot be over-estimated.

FRACTURE OF THE FIRST METACARPAL. BENNETT'S
FRACTURE

This fracture is sufficiently distinctive to require separate consideration. It is an oblique fracture of the base of the first metacarpal bone, the smaller fragment being occasionally comminuted. The mechanism of this fracture, which is commonly sustained during a fight, is that the fist strikes the opponent's head and the base of the first metacarpal, receiving the full force of the blow, is fractured by the wedge like action of the trapezium. There were five cases of this injury, of which four were sustained in the usual way, while in one case the patient was kicked on the hand. The usual treatment with Bennett's splint is unsatisfactory, as allowing of too little extension, and the method adopted has been to place a tennis ball in the palm and to pull the thumb forcibly round it, maintaining extension either by strapping or by a nail traction as described under the fractures of phalanges. At the end of ten days massage and whirlpool baths were begun, and all these cases secured a perfect result.

FRACTURE OF REMAINING METACARPALS

There were 21 cases in this group, and their distribution was as follows :—

Fracture of second metacarpal	4 cases.
Fracture of third metacarpal	1 case.
Fracture of fourth metacarpal	4 cases.
Fracture of fifth metacarpal	7 cases.
Multiple fractures	5 cases.

All were cases of direct violence and the displacement varied considerably. The most frequent was a backward displacement of the fractured ends, and the usual site of fracture was near the distal end of the bones. These cases were all treated by bandaging over a tennis ball in the palm for ten days, the patient being instructed to grip the ball to the limits of painless movement. At the end of this time massage, whirlpool baths and active movements were begun. All these patients recovered full function, one case with a fracture of all four metacarpals being a good example of the efficiency of the method of treatment. The average time under treatment was 3·2 weeks.

FRACTURES OF PHALANGES

Phalanges were fractured in 20 cases, 17 males and 3 females, and the fingers were involved as follows : Thumb, 8 cases ; index,

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6 cases; middle, 3 cases; ring, 2 cases; and little finger, 6 cases. One of these cases was an example of separated epiphysis. The mechanism in all cases was direct violence; the type of fracture was either roughly transverse or oblique. In the transverse cases the displacement is readily corrected and shows little tendency to recur, and the treatment adopted was immobilisation over a tennis ball for a week followed by massage and movement. In the oblique cases, however, there is a great tendency to slipping of the fragments, and considerable extension is necessary. The usual strapping extension is unsuit-



FIG. 2.

Fractured phalanx of thumb showing nail extension.

able in that it tends to slip and obstructs the joints. The method used has been that the forearm and hand, with a tennis ball in the palm, are fixed to a straight splint by strapping. A hole is bored through the free edge of the nail of the injured finger (a painless proceeding if carefully done), and a salmon-gut suture is threaded through and is attached by way of a rubber accumulator to a nail at the end of the splint (Fig 2). This method gives excellent extension, and allows of the slight joint movements which so greatly help to avoid stiffness. All this series of cases had perfect results, and were under treatment for an average period of three weeks.

I should like to acknowledge the great help which the

FRACTURE OF THE UPPER LIMB 361

fracture department receives from the admirable manner in which the patients are treated in the massage department. A representative of this department is present when the cases are seen, and thus an excellent liaison is established. I should further like to express my thanks to Mr. A. H. Todd and Mr. Fouché for their valuable assistance and keenness in the treatment of these cases.

SUMMARY OF INCIDENCE OF 458 CASES OF FRACTURE IN THE UPPER LIMB

	No. of cases.	Percentage of upper limb fractures.
<i>Acromion process</i>	1 case	0.21%
<i>Clavicle</i>	77 cases	16.81%
<i>Humerus</i>	70 cases	15.28%
{ upper end	19 cases	4.14%
{ shaft	7 cases	1.52%
{ lower end	44 cases	9.64%
<i>Radius alone</i>	151 cases	32.99%
{ upper end	11 cases	2.40%
{ shaft	21 cases	4.58%
{ lower end	73 cases	15.94%
{ Colles' fracture	46 cases	10.04%
{ other fractures		
<i>Ulna alone</i>	27 cases	5.89%
{ upper end	6 cases	1.31%
{ shaft	18 cases	3.93%
{ lower end	3 cases	0.65%
<i>Radius and Ulna</i>	83 cases	17.12%
{ shafts	69 cases	15.06%
{ lower ends	14 cases	3.05%
<i>Carpus</i>	3 cases	0.65%
<i>Metacarpus</i>	26 cases	5.67%
<i>Phalanges</i>	20 cases	4.36%

NOTE ON THE MEASUREMENT OF SHORTENING AFTER FRACTURES OF THE LOWER EXTREMITY

By PHILIP TURNER, M.S., Surgeon to Guy's Hospital.

ACCURATE measurement of the length of the lower extremity for the detection of shortening is often of great importance, both for diagnostic purposes after injury, and also during and after the treatment of a fracture as an indication of the progress and the final result.

For the purposes of measurement these injuries may be divided into the following three groups: (1) injuries of the hip-joint and of the head and neck of the femur; (2) fractures of the shaft and of the lower extremity of the femur; and (3) fractures of the tibia and fibula.

(1) With regard to the first group there are two satisfactory methods in common use, both of which are of great value, (a) Nelaton's line, drawn from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium, which in a normal limb passes through the summit of the great trochanter, and (b) Bryant's triangle, which measures exactly the distance from the tip of the great trochanter to a line drawn vertically backwards from the anterior superior spine, the patient being in the recumbent position.

(2) The measurement of shortening with fractures of the femur below the level of the great trochanter is much less satisfactory. Unfortunately the head and neck of the femur are thickly covered by soft tissues, and, though the internal and external tuberosities of the lower extremity are subcutaneous, there is no easily recognisable tubercle to serve as a landmark for measurements.

On this account shortening in this region is usually determined by measuring the distance between the anterior superior spine and the tip of the internal malleolus, and then comparing this measurement with that of the sound side. The obvious drawback to this is that the measurement is taken between two bony points, neither of which belongs to the injured bone. Both these landmarks are separated from the

femur by movable joints, the hip-joint in the case of the upper, and the knee-joint in the case of the lower; and unless these two joints are in exactly the same position on the two sides, a very appreciable degree of error is possible. In the case of the knee-joint, where the only movements are flexion and extension, a difference in the position of the joints is generally both readily recognised and easily corrected by altering the position on the uninjured side to correspond with that of the injured limb. With the hip, however, both recognition and correction of difference in the position of the two joints is often much more difficult, since all kinds of movement are possible in this ball and socket joint, and also, though the legs may apparently be in the same position, tilting of the pelvis may be present to a considerable degree.

Another method which has been employed is to measure from the anterior superior spine to the top of the patella; but here, again, the patella is a movable bone, whose position in relation to the femur varies with contraction of the quadriceps and with the position of the knee-joint, while the same objections are, of course, again present with regard to measurements from the anterior superior spine.

The influence of the position of the hip-joint on the length of the limb by these methods of measurement may be easily shown by the following experiment, which should be carried out on a normal person lying on his back on a couch. First measure the distance from the anterior superior spine to the top of the patella by means of an ordinary tape measure; then, holding one end of the measure steadily against the anterior superior spine, get some one to raise the foot just free from the couch and gradually to move the leg into a position of full abduction. The distance from the anterior superior spine to the top of the patella will at once begin to decrease, until, when full abduction is reached, the measurement will diminish by as much as $1\frac{1}{2}$ inches or even more. Next, still keeping the tape in position, gradually adduct the limb; it will be found that in full abduction there will be usually slight increase in length when compared with the measurement in the straight position. Similar variations will be found if the measurements be taken from the anterior superior spine to the internal malleolus. (See table below.)

The object of the present paper is to point out the importance of the head of the fibula as a bony landmark, and to show how shortening due to a fracture of the shaft of the femur can be accurately measured, and inaccuracies due to a different position of the hip-joint on the sound and injured sides can be eliminated,

by measuring the distance between this point below and the top of the great trochanter above.

The highest point of the great trochanter can be easily felt and identified, even in adipose or muscular subjects, and is a well-recognised landmark for taking measurements, as shown in its use in the methods of Bryant's triangle and Nelaton's line. The outer surface of the head of the fibula is subcutaneous and can be easily felt and identified in the living subject. On examining a prepared bone the styloid process is the most prominent point, but in the living subject is much less so owing to the insertion of the biceps and the external lateral ligament. The portion of the bone that can be most easily and accurately identified is a tubercle at the lower part of the external surface, which marks the uppermost limit of the attachment of the peroneus longus. This tubercle, as can be proved by examining the head of one's own fibula, is much more easily felt than would have seemed possible from examination of a prepared bone: this should be the point selected for taking measurements.

The measurement, then, which is suggested for the detection of shortening in cases of fracture of the shaft or lower extremity of the femur is from the highest part of the great trochanter above to this tubercle at the lower part of the subcutaneous outer surface of the head of the fibula below.

It is obvious that the distance between these points will vary with the position of the knee-joint, diminishing when this is flexed; but, as has already been pointed out, any flexion of the knee is easily recognised on the injured side and easily corrected by flexing the knee of the sound side to the same degree.

Theoretically the measurement ought to be quite independent of any position of the hip-joint or of any tilting of the pelvis. In practice, however, one sometimes finds a trifling but distinct variation in this measurement of the normal limb in extreme abduction and adduction. The difference is usually only about $\frac{1}{8}$ inch, generally lengthening, when compared with the measurement in the straight position. The explanation is probably that in these movements of the joint the trochanter swings inwards and outwards, and hence, owing to displacement of the soft tissues, its prominence varies and this leads to the slight variation in the measurement.

When the measurement is made with a tape measure on a normal limb it will be noticed that the tape follows the convex curve of the muscles on the outer side of the thigh. If a limb is measured after an old or a recent fracture this may lead to a fallacy, since the curve of the muscles on the outer side of

the thigh may be different in the injured and the uninjured limb. In the case of recent injury effusion of blood beneath the deep fascia will render the outline more convex, while in cases of old fracture the outline may be altered by bony deformity or by greater wasting of muscles than has occurred on the sound side. The difference is probably in any case but slight, but it may be overcome by using instead of the tape measure a rigid two-foot rule fitted with sliding indicators, so that the direct distance between the two bony points can be measured without following the curve of the muscles.

Measurement taken in this way is quite easily carried out and gives, I believe, the most accurate and reliable information as to shortening after fracture of the shaft or of the lower extremity of the femur.

(3) In cases of fracture of the tibia alone or the fibula alone there is usually but little shortening or deformity, but when both bones are fractured a comparison of the distance between this tubercle on the head of the fibula and the external malleolus on the injured and sound legs will show the amount of shortening, which may be considerable. Here, again, the rigid ruler with sliding indicator may be used to overcome any error due to altered outline caused by swelling or bony deformity.

The use of the tubercle on the head of the fibula as a landmark and the measurements described above will often be found of great service, in conjunction with a measurement from the anterior superior spine to the internal malleolus, in helping to locate the shortening in some old cases of injury or disease of obscure nature.

The following table, typical of a number of measurements of a normal limb, made in the three ways that have been described with the hip-joint in a variety of positions, shows the variations which occur. It will be noticed that when measurements are taken from the great trochanter to the head of the fibula they are practically uniform, the only important variation occurring with flexion of the knee-joint.

Position of Limb.	Ant. Sup. Spine to Int. Malleolus.	Ant. Sup. Spine to Top of Patella.	Great Trochanter to Head of Fibula.
Leg straight . . .	35 $\frac{1}{2}$	18 $\frac{3}{8}$	19
Hip flexed 20° . . .	35	17 $\frac{1}{2}$	19
Full abduction . . .	34 $\frac{1}{2}$	16 $\frac{3}{4}$	19 $\frac{1}{8}$
Full adduction . . .	35 $\frac{1}{2}$	18 $\frac{3}{8}$	19
Internal rotation . . .	36	18 $\frac{1}{2}$	19
External rotation . . .	35 $\frac{1}{2}$	18 $\frac{3}{8}$	19
Hip and knee both flexed to 20°	35 $\frac{1}{2}$	18	18 $\frac{3}{4}$

SOME RESULTS OF INTRANASAL OPERATION FOR ANTRAL SUPPURATION

By N. E. KENDALL, Chief Clinical Assistant Throat and Ear Department,
Guy's Hospital.

THE treatment of acute and chronic antral suppuration can be ranged under three headings.

(1) The puncture under local anæsthesia of the antrum by means of a large-bore, straight or curved needle. The pus is then withdrawn by means of a syringe and the antrum washed out either through its natural orifice or through the site of puncture.

The disadvantage of this method is that only in a very small percentage of cases is a permanent cure achieved, even though the treatment is repeated several times. Its only advantage is that it can be carried out under local anæsthesia except in very nervous patients; at the most it only requires gas.

(2) The second method of treatment is by means of the intranasal operation, which consists of removing a small portion of the anterior ends of the inferior and middle turbinate bones, and making a large opening into the antrum from the inferior meatus.

The after treatment of this method consists in washing out the antrum once a day through the nose.

The only contra-indications of this method are—

(a) in old standing cases of antral suppuration, the mucous membrane of the antrum sometimes becomes polypoid, and it is then difficult to get the antrum efficiently cleared through an intranasal opening;

(b) where the antral infection is caused by infection from the mouth, either by carious teeth or some form of dental cyst;

(c) where such an anatomical condition as septa in the antrum is present.

The advantages of this operation are numerous. Firstly, the operation is simple and short, and therefore causes the

least possible inconvenience to the patient. Secondly, the time which a patient is prevented owing to the operation from carrying on his work is very short indeed. Thirdly, the post-operative treatment is so simple that it can, if necessary, be carried out by the patients themselves after the first forty-eight hours, but as a rule, if the opening into the nose is made large enough, no treatment at all is required after that time.

(3) The third method of treatment is by means of Luc Caldwell's and Denker's operations.

In both these operations the removal of bone is carried out from the mouth, a large opening is made through the canine fossa into the antrum, and the inner wall of the antrum is then removed. The difference between the two operations is that in Denker's operation the opening from the mouth is carried further forwards and the "anterior solid angle" of the superior maxilla is removed on that side.

The advantage of these operations is that the exposure into the antrum is more direct, and it is therefore easier to clear the antrum of polypi efficiently.

The disadvantages of these operations are—

(1) firstly, the operation is more difficult than the intranasal operation, and therefore takes longer, the disturbance caused to the patient is greater, and the convalescence is more prolonged;

(2) secondly, the opening into the mouth sometimes does not heal properly, and the patient is left with a sinus into the mouth, which perpetuates the antral infection and may never close;

(3) thirdly, patients quite commonly complain of some tenderness and inconvenience owing to the scar in the mouth;

(4) fourthly, the roots of the teeth that project into the antrum and the nerves going to supply these teeth are sometimes injured during the operation.

During the past three years thirty-two cases of intranasal operation have been followed up and seen or communicated with during the past month. Twenty-two of these have been quite well ever since the operation, one has been re-operated on by the intranasal method and is now quite well, and the other nine are still showing symptoms of antral suppuration. In six of these nine cases, the openings into the antrum were found to be completely closed when recently examined, and in the other three the antral suppuration was complicated by ethmoid and frontal sinus suppuration.

Conclusions

The intranasal operation, except where contra-indicated as shown above, is the method of choice for the treatment of all antral suppuration because

- (1) it is a very simple and short operation;
- (2) only a very short convalescence is necessary;
- (3) if the operation is performed satisfactorily, so as to make the opening into the nose efficient, a complete cure will be obtained in all uncomplicated cases.

LEFT-SIDED COLON

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital,

WITH AN

ANATOMICAL NOTE ON "NON-ROTATION OF THE GUT"

By T. B. JOHNSTON, M.B., Professor of Anatomy, University of London,
Guy's Hospital Medical School.

THE accompanying illustrations are drawn from tracings taken in the routine x-ray examination of two men, who were suffering from attacks of abdominal pain. They reveal a condition of extreme rarity, which has never before been recognised except after death or during an abdominal operation.

The first patient, Mr. S., aged twenty-two, had had frequent attacks of severe pain ever since he was poisoned with bad meat in 1910. The attacks were very severe and came on without obvious cause in the lower part of the abdomen. When I first saw him in April 1914, he was having as many as two a day. An x-ray examination showed a remarkable abnormality of his colon (Fig. 1). The whole of it was situated on the left side of the abdomen, the end of the ileum passing downwards on the right side to join the cæcum, which was in the left side of the pelvis. It was thought that the symptoms might be due to appendicitis, so Mr. F. J. Steward explored. He confirmed what had been discovered with the x-rays. The appendix was slightly diseased and was lightly adherent in the pelvis. The cæcum had a very long mesentery. The appendix was removed, and the patient remained well until the end of July 1914, when he had again had occasional slight attacks of pain, but never as severe as before the operation. A second x-ray examination showed that the intestinal condition was unaltered, and that there was no stasis. In 1916 the patient passed a small renal calculus, and has since then had no return of symptoms, which must probably therefore have been due, at any rate in part, to this cause from the time of their onset.

The second patient had been explored for intestinal obstruc-

tion before I saw him in 1919, but the surgeon had failed to find the cause and indeed had failed to find his appendix; he

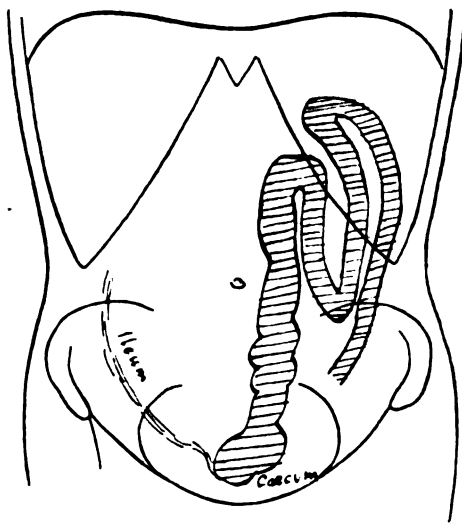


FIG. 1.

Case 1. Reproduced from tracing of a left-sided colon, visualised with the x-rays after a barium meal.

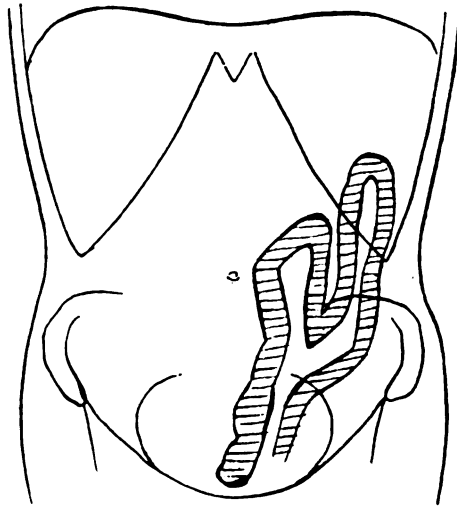


FIG. 2.

Case 2. Reproduced from tracing of a left-sided colon, visualised with the x-rays after a barium meal.

thought he discovered a rudimentary cæcum near the gall-bladder, but the x-ray examination carried out a year later showed that this could hardly have been correct (Fig. 2), as

it revealed a condition identical in almost every detail with that found in my first case. As there was no evidence of organic disease, no further operation was undertaken.

NOTE ON "NON-ROTATION OF THE GUT"

Until the human embryo reaches a length of about 8 mm. (fifth week) the gut forms a U-loop, which is convex ventrally and is suspended from the dorsal wall of the abdomen by a simple mesentery (Fig. 3). The diverticulum which subsequently forms the cæcum and vermiform appendix is situated on



FIG. 3.

Diagram to show disposition of U-loop of gut prior to its extrusion from the abdominal cavity into the umbilical cord. Observe the diverticulum which subsequently forms the cæcum and vermiform appendix.

the caudal or ascending limb of the loop, and its presence enables the colon to be distinguished from the small intestine.

Between the 8 mm. and the 40 mm. stage (tenth week), the space available in the abdominal cavity is fully occupied by the liver and the Wolffian bodies, and the rapidly growing intestinal loop is extruded into the umbilical cord, where it forms a normal umbilical hernia. At the 40 mm. stage changes occur in the vascular condition of the liver, etc., with a resulting fall in the intra-abdominal pressure and a consequent reduction of the herniated gut. When the arrangement of the gut is examined after its return to the abdominal cavity, it is found that the original U-loop has become rotated, the caudal or ascending limb having passed headwards to the left of the descending limb and then to the right across its ventral aspect, in the manner shown in Figs. 4 and 5. As a direct result of

this rotation it is found in the adult that the colon (transverse) crosses in front of the small intestine (second part of duodenum), and, as the superior mesenteric artery, which originally lies between the two layers of the simple mesentery, is also involved,

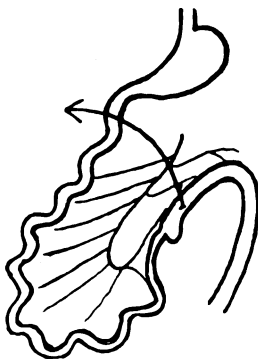


FIG. 4.

Diagram to show elongation of the intestinal loop. Observe the disposition of the branches of the superior mesenteric artery. The arrow indicates the direction in which rotation will take place.

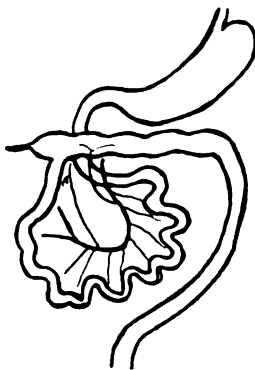


FIG. 5.

Diagram to represent disposition of gut after its return to the abdominal cavity. Rotation has occurred, with the result that the colon crosses in front of the duodenum. Observe that the *rami intestini tenuis* now arise from the left side of the superior mesenteric artery and the colic branches arise from its right side.

the vessel crosses in front of the duodenum (third part). The artery is further altered in that the branches to the small intestine arise from its left side (cf. Figs. 4, 5, and 6).

Subsequent to this rotation certain parts of the alimentary canal lose their mesenteries. The duodenum, the ascending colon and the descending colon become retro-peritoneal, and

the mesentery of the transverse colon becomes blended with the two posterior layers of the great omentum, so coming to form a part of the posterior wall of the omental bursa (lesser sac).

Cases of incomplete rotation, or of persistence of peritoneal folds which normally become obliterated, are not uncommon, but non-rotation is of comparatively rare occurrence. Cabot in 1886¹ and Chiene in 1867² met with the condition in the cadaver. In the cases described by Schrup,³ Sturgis⁴ and Corlette⁵ in 1915 the condition was found in the course of abdominal operations. Schrup,³ operating for appendicitis,

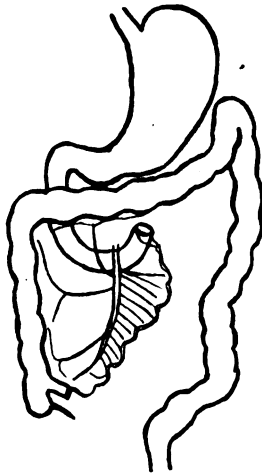


FIG. 6.

Diagram to show the disposition of the gut in the normal adult. Most of the small intestine has been removed and the cut edges of the mesentery are seen.

found the jejunum coiled up in the right half of the abdomen; the cæcum was in the left side of the abdomen behind the pelvic colon, the ascending colon being in close apposition with the descending colon. He could find no transverse colon or omentum.

Corlette⁵ diagnosed appendicitis in a man of forty-two, but on making the usual incision he found that the right side of the abdomen was entirely occupied by small intestine. A median opening was then made, and the cæcum and ascending colon were found on the left side in contact with the descending colon, the transverse colon and omentum being apparently absent; they had a mesentery, which was attached along the middle line in front of the vertebral column. The ileum came up to the cæcum from below and from the right but entered

its left side as usual. The inflamed appendix, which had a long meso-appendix, was removed.

Sturgis,⁴ operating on a woman of twenty-two with gall-stones, found all the small intestine on the right side. The cæcum lay free in the pelvis; the ileum and appendix were attached to it in the normal way. The ascending colon was to the left of the middle line, and the transverse colon was subsequently seen with the x-rays to pass from it to the splenic flexure, which was then found to be normal in position. A thin lace-like omentum passed from the stomach over the small intestines.

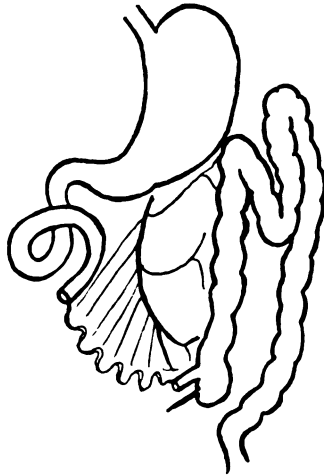


FIG. 7.

Diagram to show the disposition of the gut in the adult in a case of non-rotation. Most of the small intestine has been removed and the cut edges of the mesentery are seen. Compare the duodenum, the colon and the superior mesenteric artery and its branches with the corresponding structures in Fig. 6. (*After Huntington.*)

Huntington⁶ describes four cases, the specimens of which are in the Columbia University Museum. His figures (Fig. 7) show a very striking resemblance to the tracings of the two cases here recorded. They also illustrate a feature which may ultimately prove to have some bearing on the cause of the condition. In all four subjects the duodenum is increased in length and in two of them it is spirally coiled.

I recently saw a similar case during an operation for gastro-enterostomy, performed at Guy's Hospital by Mr. E. C. Hughes. So far as I was able to determine at the time, rotation of the gut had not occurred.

The condition is always present in those cases of extroversion of the bladder which are complicated by the presence

of intestinal orifices on the extroverted area (extroversion of the cloaca).⁷

Non-rotation of the gut results in the following subsidiary and dependent anomalies.

(1) The colon occupies the left half or less of the abdominal cavity, while the small intestine lies to its right side.

(2) The duodenum is elongated and its mesentery usually persists.

(3) The colon does not cross ventral to any part of the small intestine.

(4) The whole of the colon retains its mesentery and no part of this mesentery is blended with the great omentum.

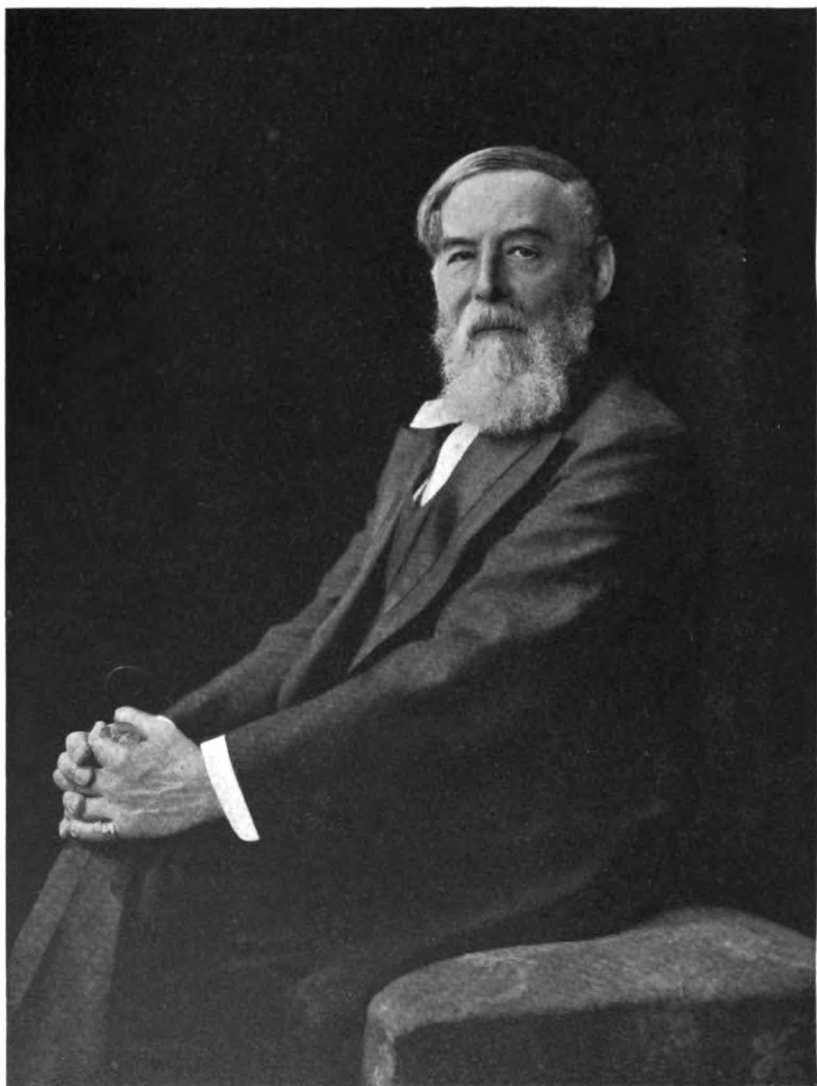
(5) The superior mesenteric artery lies dorsal to the duodenum. The *rami intestini tenuis* arise from its right side and the colic branches from its left side.

Rotation of the gut around the superior mesenteric vessels occurs to a greater or lesser degree in practically all mammals, but it does not occur in lower vertebrates. The condition, therefore, is clearly associated with the growth of the colon. Frazer and Robbins⁸ have put forward the view that rotation is brought about by a number of factors which act, for the most part, in a purely mechanical manner. According to their observations, the occurrence of rotation depends on the narrowness of the opening into the sac of the normal embryonic umbilical hernia. On account of the relatively large size of the cæcum, it is the last part of the gut to return to the abdominal cavity and it has to accommodate itself to the manner in which the coils of the small intestine have already disposed themselves. While the whole process is by no means clear, it appears to be certain that many of the factors which contribute to the production of rotation are purely mechanical. If the view put forward by Frazer and Robbins be accepted, then cases of non-rotation can be explained by the early return of the cæcum to the abdominal cavity, when the normal umbilical hernia is reduced at the 40 mm. stage, a condition to be attributed either to a diminution in size of the cæcum or an increase in the size of the opening out of the general peritoneal cavity.

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SIR JAMES GOODHART, BART., M.D., LL.D., F.R.C.P.

Born 1845. Died 1916.

IN MEMORIAM

SIR JAMES FREDERIC GOODHART, BART., M.D.,
F.R.C.P., LL.D.

By LAURISTON E. SHAW, M.D., Consulting Physician to Guy's Hospital.

JAMES FREDERIC GOODHART, like his two immediate predecessors amongst the physicians of Guy's Hospital, was the son of a general practitioner. It is difficult to judge whether the custom for the sons of medical men to follow their fathers' profession varies much in frequency from time to time. It has always been common and even to-day is sufficiently so to lead one to conclude that, whatever may be the disadvantages of general practice, there are sufficient compensations to make a medical father indisposed to thwart the natural inclinations of his son to follow in his footsteps. Goodhart's inclination towards medicine can, however, hardly have been aroused by intimate knowledge of the conditions of professional life in his home. His father practised in the Camden Road, where his son James was born on October 24, 1845, and where the father died before his son was seven years of age. The widowed mother was left with five children in somewhat straitened circumstances, and at the age of ten James entered Epsom College as one of the first foundation scholars. He was at Epsom nine years, and one of his school-fellows says of him that "he was cheerful, good-tempered, and diligent." He must have been rather a small and not very athletic boy, and there are reasons for believing that he did not greatly enjoy his school experiences. But whether as the result of the training at school or of his knowledge of home conditions he clearly worked well whilst there, and acquired a habit of working hard which persisted throughout his life.

On leaving Epsom, Goodhart proceeded to Guy's Hospital, obtaining an entrance scholarship in Arts. In his second and third years he gained various prizes, and later obtained the Treasurer's Gold Medal in Medicine. His enthusiasm and industry as a medical student were rewarded by his election to the newly-created post of House Physician, an appointment

which at that time entailed the general responsibility for all the medical beds. At the end of this appointment he became the first Resident Medical Officer of the Evelina Hospital for Sick Children. In these two resident posts Goodhart took advantage of his opportunities for original observation, and made a large number of records of his patients' temperatures by means of the clinical thermometer, an instrument which was at that time only just coming into general use by the profession. These collected thermometric records were published in the *Guy's Hospital Reports* in 1870, the first of the long series of professional communications which are set out in the list of Goodhart's published writings compiled by Mr. J. H. E. Winston, one time librarian at Guy's, and printed in 1919.

Goodhart's success in obtaining these two coveted resident appointments evidently aroused his ambition to take a high place in his profession, which he now recognised could not be obtained unless he possessed a university degree. To graduate at London would have entailed a complete retracement of his steps in the medical school, so he proceeded to Aberdeen, where in 1871 he graduated M.B., C.M., with highest honours.

On returning to Guy's with his degrees, he found no vacancy on the teaching staff which would form a natural step towards securing his now confirmed ambition to become one of the Physicians to the Hospital. Fortunately, as he often afterwards admitted, the only available post was on the surgical side, and he was appointed Surgical Registrar in 1872, an office which he held for two years, thus greatly widening the basis of his professional experience and avoiding the disadvantages of too early specialisation.

In conjunction with his surgical registrarship he became joint Demonstrator of Morbid Anatomy with Hilton Fagge, and thus started the pathological work which was destined to engross the greater part of his attention for many years. His interest in the work in the post-mortem room at Guy's was enhanced by his simultaneous appointment as assistant in the Pathological Department of the Royal College of Surgeons, in connection with which post he undertook the preparation of a supplement to the Catalogue of the College Museum, and later gave great assistance in the issue of a complete new edition. He became an indefatigable exhibitor of specimens of morbid anatomy at the Pathological Society, and was frequently chosen either alone or in conjunction with one of his colleagues to report on obscure specimens exhibited by other members of the Society. From 1883 to 1885 the Society had the advantage of his services as honorary secretary. All this time he was steadily pursuing

his routine work as demonstrator in the post-mortem room at Guy's. His demonstrations were attended by large numbers of students, who appreciated greatly his clear exposition of the appearances of diseased organs, his explanations of the interrelation of the morbid processes in distant parts of the body, and of the connection between the findings in the post-mortem room and the symptoms observed during life. Goodhart maintained and handed on the tradition at Guy's, whereby the staff demonstrators wrote out in full with their own hands a complete report of all the points of interest observed in conducting each post-mortem examination. No better monument is needed to the powers of observation, knowledge, and industry of Goodhart and his three great predecessors, Wilks, Moxon, and Fagge, than the bound volumes of their post-mortem records still available for study in the Gordon Museum of Pathology. In 1882 Goodhart became Curator of the Museum, and in 1884 Lecturer on General Pathology. At this time the course on General Pathology was a summer course delivered on Saturday mornings. This was the only systematic course of lectures Goodhart delivered in the medical school. He gave the ordinary short courses of clinical lectures in turn with the other physicians and assistant physicians, but it did not fall to his lot to take part in the systematic lectures on Medicine, which in his time were given by the two senior physicians. Goodhart's lectures in pathology were not such a success as was expected from his profound knowledge of the subject after fifteen years' work in the post-mortem room. The lectures were elaborately prepared and eloquently read, but the students missed the simple, clear expositions and colloquial illustrations to which they were accustomed in his daily teaching at the bedside and in the post-mortem room.

While devoting so much attention to pathology in these early years, Goodhart was at the same time in close touch with the clinical side of his professional work. After two years as Surgical Registrar he took up the corresponding appointment in the medical wards, holding office for three years. At the end of this period the number of assistant physicians being increased from three to four, he became permanently attached to Guy's by being elected the fourth assistant physician.

Two years before this, however, in 1875, he had been made physician to out-patients at the Evelina Hospital, close to Guy's, and in due course becoming full physician he worked in this special hospital for children continuously for thirteen years. In these modern days of early specialisation and the supposed necessity of exclusive devotion to one small section of profes-

sional work if one is to make a success of it, it is interesting to note in Goodhart's case the undoubted success with which for the first fifteen years of his career he worked simultaneously at pathology, the diseases of children, and general medicine. He certainly did not use his opportunities in pathology merely as a stepping-stone to clinical work. He threw himself into its study with so much energy and gained so high a reputation in this subject, that some opposition to his appointment as assistant physician was aroused on the ground "that he was too good a pathologist ever to become a successful clinician." Subsequent events, however, might well invite speculation as to how far Goodhart's unusual clinical acumen and special diagnostic capacity may have been due to the fact that he alone of the physicians to Guy's Hospital was appointed Demonstrator of Morbid Anatomy before he was elected assistant physician. Certainly his long experience in the post-mortem room must have been largely responsible for the reputation he held for many years amongst the students at Guy's of being more capable than any of their other teachers of accurately forecasting the appearances that would be found at an autopsy.

Mention has already been made of the large number of contributions that Goodhart made to the Transactions of the Pathological Society. As he proceeded with his work in children's diseases and general medicine, he published in the *Guy's Hospital Reports* or other appropriate journals and transactions cases of interest or conclusions that he came to as the result of his clinical observations and his experiments in treatment. His first contribution in 1870 was, as has already been said, on Thermometry, and the following year he published his Aberdeen graduation thesis on Artificial Tuberculosis. From that date until his death forty-six years later, there were only three years in which Goodhart did not make some contribution to medical literature. In many years there were more than a dozen separate communications from his pen. His most important publication was his one book, *The Student's Guide to Children's Diseases*. This was first published in 1885, and was based on the ten years' experience he had then had at the Evelina Hospital. It was a most attractive volume, was warmly received, and at once established Goodhart's position as a leading authority on its subject matter, thus increasing the demands which were already being made by general practitioners for his help in difficult medical cases.

In the same year in which his book on Children's Diseases was published it became clear that Goodhart had no intention of restricting his attention to any special branch of professional

work. His brilliant junior colleague Mahomed, after he had undertaken to deliver the Bradshaw Lecture at the Royal College of Physicians, died from typhoid fever, and Goodhart, being chosen to take his place at short notice, selected as the title of the lecture "Morbid Arterial Tension," a subject which Mahomed by his work with the sphygmograph had done much to elucidate. The lecture served as a memorial of his late colleague's work and at the same time established Goodhart's reputation, not only as an acute observer, but also as an original thinker able to make use of observed facts to throw light on problems that had hitherto baffled his fellow-workers.

From this time forward Goodhart was frequently invited by medical societies, both in London and the provinces, to give addresses on medical subjects, to the preparation of which he devoted much thought. He carefully eschewed medical politics and social questions, and rarely chose as the subject of his address complicated problems in connection with advancing medical knowledge.

His addresses attracted large audiences and were eagerly read in their published form. He chose taking titles for his lectures, and with racy humour, but in the most sympathetic manner, gently bantered his audience on the follies of the doctors and the foibles of their patients. The victims of his kindly satire, both lay and medical, thoroughly enjoyed the exposure of their weaknesses, perhaps because they believed that they saw the applicability of the criticism to their confrères and fellow-sufferers rather than to themselves. In these addresses, as well as in all his dealings with patients and fellow-practitioners, Goodhart held high the standard of professional integrity, sternly condemning those members of the profession who might be disposed to make capital out of the weakness of human nature, and insisting on the golden rule and on the doctor's duty ever to put the interest of his patient before that of his own reputation. These addresses might almost be regarded as medical sermons. Such sermons, in fact, as a bishop might preach to the clergy of his diocese, not so much with the object of increasing their knowledge of theology, but rather to incite them to greater and higher service to their parishioners. The address of this character which produced the greatest impression was probably the series of three lectures on "Common Neuroses" delivered before the Harveian Society in 1892. The title of these lectures is not a very happy one, and the progress of medical science will enable the modern reader to find many physical explanations of conditions therein attributed to neurosis. Their main lesson is as much needed

to-day as when they were written. It can be conveyed in a brief quotation. "I wanted to insist, because I am sure that at the present day we are too likely to forget, that the highest position we can take is to cure people by advice rather than by drugs, to make the public pay for the use of our brains and not for a prescription of so many ounces of physic." The kind of advice Goodhart wanted patients to have was such as would lessen that part of their trouble which arose from ignorant fear and excessive introspection. He held it to be the doctor's duty to endeavour to discover simple and satisfying explanations of alarming symptoms, and to direct the patient's attention to the avoidable factors in his environment which were causing or aggravating his ailment.

Similar addresses followed in due course, some of the titles being "Common Diseases Mistaken or Mistreated," "The Limitations of Medicine," "The Fringes of Disease," "Man and Medicine," "Opinion the Salt of Fact," "Friends in Council," "When Memory Sleeps." Finally, in 1912, four years before his death, Goodhart delivered the Harveian oration before the Royal College of Physicians on "The Passing of Morbid Anatomy." The title again in this case was perhaps more concise than accurately descriptive of the subject of the lecture. The oration was a masterly and philosophic discourse on the progress of medical and allied sciences, encouraging a broad outlook on future possible development, not only in medical but in all knowledge. Goodhart had witnessed the gradual recognition of the fact that disease was not a mere matter of physical change in the organs and tissues of the body, and welcomed the attempts being made in all directions to discover the physiological as well as the anatomical basis of ill-health. He gave the warmest encouragement to the junior members of the profession to continue and increase their efforts to solve the problems of life and disease by the aid of the new branches of science, which had come into prominence during his life-time, and with the practical details of which he was not familiar. However satisfying the title of the address may have been to those who had neglected or did not desire to perfect their knowledge of morbid anatomy, the full comprehension of the orator's views leaves no room for doubt that Goodhart recognised as fully at the end as at the beginning of his career that the study of morbid anatomy is the foundation on which all sound medical knowledge must be based.

Goodhart was assistant physician to Guy's for nine years, his promotion to the full staff being due to the vacancy caused by the sudden death of Moxon in 1886. On taking complete

charge of patients in the wards Goodhart developed to the full his special gift of clinical teaching. He made little use of the formal didactic method whereby some of his colleagues helped their pupils to pass their examinations. His following around the wards was, therefore, a moderate one, composed largely of senior students and men already in practice. They learnt rather from what they saw and overheard than from what they were told. Goodhart's intimate and sympathetic conversation with his patients, and his exhaustive examination of their mental and physical condition, provided an invaluable lesson to his pupils which stayed by them long after their contests with their examiners were entirely forgotten.

Goodhart's immediate senior amongst the physicians was Frederick Taylor, who was, however, his junior in age, so that in the natural order of things Goodhart could never expect to hold the position of Senior Physician. After being full Physician for thirteen years, he resigned his appointment at the age of fifty-three, seven years before the time when retirement would have become compulsory by the rules of the Hospital. The premature termination of Goodhart's active and valuable service to the Hospital and Medical School was universally regretted. Some of his colleagues regarded his voluntary retirement as in a sense a desertion from the post of duty. Those, however, with whom he discussed the matter before taking this important step knew that he regarded his attachment to Guy's as an inestimable privilege, which he was anxious that his juniors who were waiting on the lower rungs of the ladder should share with him at the earliest possible date. He was aware of the hardship that is often entailed by the inevitable delays in a system of promotion by seniority. It was characteristic of the modesty of his disposition that he had no doubt but that the services of his juniors would come to be equally as valuable as his own both to the patients in the wards and the students in the Medical School. On his retirement he was appointed Consulting Physician to the Hospital.

Goodhart started practice in Finsbury Square, but soon moved to the West End, living first in Weymouth Street and later in Portland Place. At Guy's, as assistant physician, he worked with Sir William Gull as his senior, and so came to deputise for him in private practice during his absence from London. This position and the untimely deaths of some of his seniors on the staff of Guy's secured for him a large share of consulting work at a somewhat early age. He was extremely popular as a consultant both with general practitioners and patients, and was for many years probably the busiest consult-

ing physician in London. He was one of the first consultants to refuse to visit patients in their own homes without the presence of an attending general practitioner, and later he announced on his appointment cards that he did not undertake the treatment of patients except in co-operation with their medical attendants. He believed that in this way better relations would be established between the two branches of the profession. In his dealings with his patients he was most sympathetic and his general outlook was one of cheerful optimism. However grave might be the condition disclosed by the consultation, he felt it his duty to emphasise whatever hopeful features might be present and to leave the patient's confidence in his medical attendant unimpaired.

In 1899 Goodhart had the degree of Doctor of Laws conferred upon him by the University of Aberdeen, and was created a Baronet on the occasion of the coronation of His Majesty George V.

Goodhart allowed himself few social relaxations and took little part in sports or athletic games. In his younger days his devotion to his work at the Hospital was so great that when he became engaged to be married, although his fiancée lived but a few hundred yards from his home, he only allowed himself the pleasure of visiting her once a fortnight. He generally enjoyed good health and took much pleasure in country life. At one time he had a country house in the New Forest, and subsequently moved to Holtye, near East Grinstead. One of his chief joys was the entertainment of his numerous friends in these country homes, with their beautiful gardens, in the cultivation of which he took great interest.

He married in 1879 Emma, daughter of Mr. William Bennett of Ashgrove, by whom he had two sons; the elder, Ernest, a barrister, and the younger, Gordon, who follows his father's profession, and is a member of the staff of University College Hospital. For many years Goodhart and his family took an annual holiday in the winter on the Riviera.

For some years his wife's delicate health was a source of constant anxiety, and her death in 1915 was a great blow. On the anniversary of his wife's death Goodhart began to fail in health, and he died on May 28, 1916, in his seventy-first year. His body was cremated, and the ashes were buried at Holtye.

PROTEIN-SENSITISATION AND FOCAL SEPSIS IN THE ETIOLOGY OF CERTAIN SKIN AFFECTIONS *

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PART I

PROTEIN-SENSITISATION

THE basis of our knowledge of the subject of protein-sensitisation is the experimental work that has been carried out on hay-fever, and Blackley¹ was probably the first to perform cutaneous tests with pollens, which, indeed, he did as far back as 1865. He conjectured that the "granular matter" in the centre of the pollen-grain would prove to be the toxic element, and in this he was right. Since his day Dunbar in Hamburg, Freeman² in this country, Koessler,³ Chandler Walker,⁴ Goodale,⁵ Scheppepegrell,⁶ Oppenheimer and Gottlieb,⁷ and others in America, have established the diagnosis of hay-fever by cutaneous tests, and its treatment by specific desensitising injections on a firm basis. In this connection it may be mentioned that ragweed, which is so potent a cause of hay-fever in some parts of America, may also cause a dermatitis, and persons with this cutaneous sensibility may be successfully desensitised by injection of ragweed protein.

Apart from hay-fever we know now, chiefly as the result of the work of Walker and Freeman, that a considerable percentage of patients with true asthma are sensitive to one or more proteins, either of animal, vegetable, or bacterial origin, the asthma being part of a general reaction in the individual towards the offending protein; successful treatment has resulted either by preventing the patient from exposure to the protein to which he is susceptible, or by giving injections of it in varying dilution whereby he is desensitised. It has long been noted that asthma is frequently associated with urticaria or eczema—

* Part of this article formed the subject-matter of a paper read before the Dermatological Section at the meeting of the British Medical Association at Newcastle this year, and is herein incorporated by kind permission of the Editor of the *British Medical Journal*.

indeed Sir Andrew Clark⁸ suggested that asthma was due to an urticarial swelling of the bronchial mucous-membrane—and investigations have now been carried out in order to determine the sensibility of patients with urticaria and eczema towards the various foreign proteins, principally those contained in food substances.

Thus Schloss⁹ in 1915 reported his observations on 43 cases of food-idiosyncrasy in children. He pointed out that the toxic disturbances due to food intolerance were urticaria and angioneurotic oedema, eczema, asthma and bronchitis, gastro-intestinal symptoms—vomiting, pain and diarrhoea—and eosinophilia. Proteins to which he discovered idiosyncrasies in his patients were those of milk, egg, beef, wheat, rice and other cereals, various nuts, and horse-protein. As a rule susceptibility towards more than one protein was found in each case. He showed that positive cutaneous reactions were given towards the proteins of the toxic foods, and he noted—a fact I particularly wish to emphasise—that the cutaneous reactions, and also the toxic disturbances, might disappear for some time after food poisoning. Thus in four cases of allergy or susceptibility to egg, the reaction disappeared for several weeks after illness due to ingestion of egg. The same phenomenon, of course, is seen in experiments on anaphylactic shock in animals, for, when an animal recovers from an intoxicating dose of protein, it becomes temporarily immune to further injections (anti-anaphylaxis); susceptibility is again, however, developed in from one to three months.

In two of Schloss's patients it was possible to carry out observations on the occurrence of anti-anaphylaxis:—

"Both patients reacted to the ingestion of egg by the development of general urticaria, which appeared within one to three hours. Following each attack, the cutaneous reaction disappeared for from twenty-two to forty days, and during this period the ingestion of egg was without results. With the reappearance of the reaction, egg again caused the usual symptoms. This observation was made a number of times on both patients. These results serve to explain how anaphylactic disturbances may be intermittent or cyclic, even though the food responsible was ingested continuously. They also indicate the necessity of making repeated tests in suspected cases."

At the same time, by giving a food substance, to which there is an idiosyncrasy, in gradually increasing quantities, immunity may be established, and the cutaneous reaction will then disappear.

Since Schloss's work numerous important papers have been

written upon this subject, although they do not appear to have obtained much recognition in this country. White¹⁰ in a preliminary report stated that in eczematous infants fat and starch were usually present in excess in the faeces, and he also reported results of cutaneous tests for which he used fat-free milk, egg albumin, salt-free butter, lactose and oatmeal water. His observations at that time, however, were probably of little value, for he stated that the "maximum result observed has been a pink-red elevated papule, never a wheal or vesicle," and it is therefore likely that many reactions which he regarded as positive were not really so. Moreover, the presence of excess of fat and starch in the stools of eczematous infants does not necessarily indicate that excess of fat and starch in the diet is the cause of the eczema: it may be that the infant is incapable of digesting certain foods—cereals for example—and that it is the protein moiety which is responsible for the eczema, the starch being excreted in the faeces unchanged. MacBride and Schorer¹¹ in a paper on "Erythematous and urticarial eruptions resulting from sensitisation to certain foods," discuss the theory of anaphylaxis, and make the interesting observation that animal intestinal parasites are capable of rendering certain foods toxic, *e. g.* eggs, and that destruction of the parasites may produce immunity to the food in question. Other important papers have been published by Blackfan,¹² Towle,¹³ Highman and Michael,¹⁴ Ramirez,¹⁵ and Engman and Wander.¹⁶ References to these will be made in the second part of my paper, especially to that by Engman and Wander.

CAUSES OF PROTEIN-SENSITISATION

Influence of Heredity.—There is no question that heredity is a very important factor in many cases of protein-sensitisation, and it is interesting to note that Czerny laid stress on the hereditary factor in the genesis of his exudative diathesis. Cooke and Van der Veer¹⁷ obtained a family history of the disease in patients with hay-fever in a considerable percentage of their cases, and Freeman² has published some striking charts showing how all the "toxic idiopathies," as he terms them, run in families, and there is no doubt that sensitised persons transmit to their offspring not necessarily their own specific susceptibility, but "an unusual capacity for developing bioplastic reactivities to any foreign protein" (Cooke and Van der Veer).

In my own cases of asthma and anaphylactic eczema the family history has been in some instances very striking. Thus

in one family the father, whom I have not seen, is an asthmatic, the daughter has hay-fever, and the boy came to me with eczema due to oats, and he also suffered from urticaria whenever he ate strawberries.

Influence of Gastro-intestinal Disease.—It is probable that acquired sensitisation to food and bacterial proteins depends frequently on the state of the alimentary canal, and that incomplete digestion, or a catarrhal condition of the intestinal mucous membrane may result in the absorption of proteins direct into the blood stream, thereby rendering them capable of acting as antigens. Barnathon¹⁸ states that he was able to cure urticaria in a woman, whose attacks were produced by shellfish, when he gave her pepsin and hydrochloric acid for her achlorhydria, and I have recently seen a lady with chronic urticaria of several months' duration, in whom the eruption rapidly yielded to full doses of dilute hydrochloric acid after meals.

THE NATURE OF PROTEIN-SENSITISATION

To sum up our present knowledge of protein-sensitisation, we may say that certain persons are peculiarly liable to develop toxic symptoms when exposed to the influence of certain food, animal, plant, or bacterial proteins, drugs, chemicals, etc., that this tendency is very markedly hereditary, and that idiosyncrasy towards more than one substance is the rule. How far the morbid reactions—asthma, urticaria, and gastro-intestinal disturbances—which result from these idiosyncrasies, are dependent on anaphylaxis, it is difficult to say. Freeman,² who prefers the name "toxic idiopathies," says that they "do not fall into line with the phenomena of anaphylaxis as demonstrated on a guinea-pig," but this is certainly not invariably true, for, as Schloss has remarked, in cases of marked allergy to egg or milk, in which the patient's symptoms were comparable to anaphylactic shock in animals, it was possible passively to sensitise guinea-pigs to the proteins of these foods by a preliminary injection of the patient's blood or serum, and the transmission of passive anaphylaxis to guinea-pigs was also obtained by Bruck in cases of urticaria due to pork, and by Flandin and Tzanek in that due to mussels. Moreover, Widai has shown that in urticaria of alimentary origin the outbreak of the eruption is preceded by a *crise hémoclasique*, with fall of blood-pressure and sudden leucopenia, exactly comparable to that observed in animals with anaphylactic shock.

It is difficult to explain susceptibility towards non-protein drugs such as quinine, or towards external irritants, on the

grounds of anaphylactic sensitisation, and yet the accompanying phenomena are often so similar to those of true anaphylaxis towards protein substances as to suggest that they are closely related.

CUTANEOUS TESTS FOR PROTEIN-SENSITISATION

The proteins I employ are made by the Arlington Chemical Co., under Chandler Walker's directions, and I understand that Parke, Davies & Co. are also now putting them on the market in America. The techniques of different investigators differ in certain details. A Von Pirquet scarifier is usually employed, but I use the end of a small tenotomy knife. Preliminary cleansing of the skin is usually unnecessary, and, according to Engman and Wander,¹⁶ if alcohol be used, it may adversely influence the reactions. The flexor surface of the forearm is the most convenient site for the tests, but I have also performed them on the chest and abdomen. With regard to the forearm, it should be noted that even control scratches vary, those near the elbow producing more reaction than those near the wrist; for this reason several controls should be made at different levels. This fact I observed early in my investigations, and Highman and Michael¹⁴ have independently made the same observation. The scratches, which should not be deep enough to draw blood, are covered with a drop of decinormal sodium hydroxide, and then a small quantity of protein is rubbed in, a fresh applicator (*e. g.* a piece of wood or a tooth-pick) being used for each substance. To the controls the sodium hydroxide alone is applied. To pollen, animal, and food-proteins the response is usually rapid, but bacterial reactions may be delayed for several hours. A typical reaction consists of an erythematous patch, with a central urticarial wheal, and the results must be judged by comparison with the normal controls, since the latter differ considerably in different subjects. In my experience the bacterial tests are not very satisfactory, possibly because in a group, such as the streptococci, there are a number of strains which are pathogenetically quite distinct, but which at present we are unable to differentiate by cultural or other means.

Without entering upon a lengthy discussion of the subject. I may say that, in my opinion, the cutaneous tests are of very great value, but too much must not be expected of them; a strong reaction is almost always an important aid to diagnosis and treatment, a doubtful reaction may be equally important or of no practical significance at all. It must also be re-
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bered that group reactions occur; thus a horse-asthmatic will give a strong reaction to horse-protein, and a positive, though smaller reaction to the proteins of other members of the horse-family, such as the zebra, donkey, etc., and a person sensitive to oat will probably also give reactions to rice, barley, rye, but not necessarily to wheat. This grouping presumably depends on a kindred chemical composition.

LOCAL SENSITISATION OF THE SKIN

A fact which I think is of considerable importance is that certain portions of the skin may become sensitive to external irritants, or to toxins absorbed from within, while other portions remain quite immune.

Markley¹⁹ has published a remarkable instance of a woman who suffered from an acute erythematous and papular eruption, involving the face, neck, chest and anterior surfaces of the forearms. Eventually this was shown to be due to the fact that she was in the habit of cleaning out a guinea-pig hutch, and allowing the animal to run about over her shoulders. Absence from home always resulted in the rapid disappearance of the eruption, and removal of the guinea-pig was followed by permanent cure. Tests were made with guinea-pig hair applied to the skin for some hours. It was found that application of the hair to parts of the skin that had been involved in the original eruption produced an acute dermatitis with vesication, which lasted for three days, whereas the skin, in places where no eruption had occurred, remained unaffected even after six hours' application of the hair. Control tests were made on another person, and with the hair of other animals, with negative result.

In this connection I may mention an interesting phenomenon which I observed when working with "mustard gas" in France.

I produced a small superficial burn on my *left* forearm by short exposure to this substance, which healed completely in about a week without leaving any trace. A few weeks later (while doing further experiments) I burnt myself very badly in the *right* antecubital fossa, and the burn was followed by sloughing of the skin and intense lymphangitis with oedema; while the pain and inflammation were at their height, a patch of erythema with vesicles appeared spontaneously exactly at the site of the original superficial burn that I had produced on the left arm some weeks previously. There was no possibility of this being due to accidental exposure of this area to a further quantity of mustard gas, and I can only conclude that this patch of skin had become sensitised, and reacted when absorption took place from the severe burn on the other arm.

Similar observations were, I believe, made among those employed in the manufacture of mustard gas, and one sees the same phenomenon in certain diseases of the skin, such as lupus erythematosus.

Thus, a girl of twelve years was under me for typical lupus erythematosus of the fingers of both hands. She had previously had a patch on the left cheek, of which no trace was apparent when I first saw her. She had very large septic tonsils, which were enucleated, and within a week after the operation the patch on the left cheek reappeared and remained for a few weeks, when it disappeared completely without leaving any trace. Autogenous streptococcal vaccine prepared from the tonsils was given, and after a dose, which was apparently rather too large, the patch on the cheek recurred exactly in the same place as before, only once again to disappear completely.

Another case of great interest was referred to me in October 1920, by Dr. Mutch. The patient was a lady who was under treatment for rheumatism. In April 1920 she had a carbuncle on her left thigh, and since then she had been subject to recurrent attacks of boils, chiefly around the vulva. Every time a new boil appeared a *crop of urticarial wheals would arise around the scar of the carbuncle*, but nowhere else. In this case we must conclude that the skin at the site of the carbuncle had become sensitised to the staphylococcus aureus, and, when a fresh infection with this organism took place in the form of boils, a local anaphylactic urticarial reaction occurred at the site of the original infection.

Numerous other examples of this acquired local susceptibility of the skin could be given, and, of course, Von Pirquet²⁰ observed the phenomenon in his work with tuberculin, for he found that the skin of his left arm, which he habitually used for experiments, was sensitised to tuberculin in a dilution of one in a thousand, while that of his right arm was unaffected by a solution ten times as concentrated.

FOCAL SEPSIS

We must now consider the question of focal sepsis in its relationship to dermatology. By focal sepsis we mean a chronic infection of some region of the body, the local resistance of the tissues being inadequate, so that bacteria are capable of active growth, and of producing toxins which are absorbed into the system, or of themselves passing into the bloodstream, whereby an actual bacteriæmia results. It is not clear as yet to what extent the toxic disturbances resulting from a focal infection depend on the direct action of bacterial

toxins, and to what extent they are anaphylactic or allergic manifestations, the body having become sensitised to the protein of the pathogenic bacteria, but I do not propose to discuss this question.

By far the commonest primary foci of infection are the teeth, the tonsils, the nasopharynx and nasal sinuses, and possibly the intestines. It is, however, very difficult to estimate the extent to which infection from the intestines occurs, owing to the complexity and enormous variety of micro-organisms that abound in them. Freeman,² however, quotes a most interesting case, communicated by Matthews, of severe asthma, in which no infection of the bronchi was found, but in whom a history of recurrent diarrhoea was obtained. Examination of the faeces showed infection with *B. pyocyaneus*, and administration of a vaccine of this organism cured both the asthma and the diarrhoea. There seems little doubt that the bowel may be a secondary focus for chronic *Streptococcus longus* infection, the primary foci being usually those above-mentioned, and in cases of intestinal stasis it is probable that toxæmia occurs not only from the products of excessive putrefaction and fermentation, but also from the *B. coli communis*, and variants of the *B. coli* group. Moreover, as has been remarked, in persons in whom digestion and assimilation are incomplete, or who suffer from inflammatory conditions of the intestinal mucous membrane, protein substances, which are capable of acting as toxic antigens, may be absorbed direct into the bloodstream and provoke anaphylactic reactions.

The importance of oral sepsis and chronic infection in the upper respiratory passages is twofold: not only may direct intoxication from them occur, but the constant swallowing of pus from such foci will set up gastritis, and the stomach, should its secretion of hydrochloric acid fail, as is often the case, will allow virulent living organisms to pass into the intestines, and invasion of the intestinal wall and mesenteric glands may result. Not only is a secondary infective focus thus created, but in the presence of an abnormal bacterial flora excessive fermentation and putrefaction of foodstuffs occur with the formation of highly toxic substances. For a discussion on this subject I would refer to the writings of Bassler.

Apart from the foci already mentioned, other possible ones exist, such as the appendix, the gall-bladder, the lungs, the ear, the kidneys and bladder, the posterior urethra, the prostate and seminal vesicles, and the female pelvic organs. One must not forget, too, that the skin itself may be a source of dangerous infection. I would particularly emphasise two points: first,

that when a focal infection is suspected, x-ray examination of the teeth should be made whenever practicable, and secondly, that virulent infection of the tonsils and nasal sinuses may exist without any symptoms referable to them being present. Particularly is this the case with the tonsils; in some cases very little evidence of infection in them is apparent on examination, and yet, on removal, pent-up pus may be found in considerable quantity. Another important point, with reference to the tonsils, is that partial removal with a guillotine, as is so often practised, is a positive danger: it results in scar-formation, whereby septic material is shut up in the tissue that is left. Moreover, it cannot be too strongly emphasised that the mere removal of tonsils and adenoids does not by any means prevent a recurrence of nasopharyngeal infection.

Unfortunately in many cases, although the primary sources of infection may be dealt with satisfactorily, they have existed so long that secondary foci, such as the intestines and lymphatic glands, have become established, and treatment is then apt to be unsatisfactory: one sees, indeed, persons whose tissues seem saturated with infection beyond hope of repair.

PART II

IN this second part of my paper I propose to consider some of the diseases of the skin of whose association with focal infection or protein-sensitisation there is definite proof, and some in which such association is probable, but has not yet been certainly demonstrated.

ERYTHEMA-URTICARIA-PURPURA GROUP

The various conditions included in this group, like eczema, are not, of course, diseases of definite entity, but merely represent cutaneous reactions towards a great variety of toxic agents, which may affect the skin from within or without. They form a series of reactions of different intensity, and may all be present in the same person, and apparently be produced by the same toxic substance. Some time ago I saw an old man, who had eaten a heavy meal in a fried-fish shop. Within twelve hours he had developed acute erythema of his chest, acute vesicular eczema of his face and neck, urticarial wheals on his back and thighs, purpura on his legs, and bullæ on his ankles and feet. The purpuric and bullous reactions were doubtless partly to be explained by the dependent position of the parts on which they occurred, but the case illustrates very

well how the various forms of toxic rashes merge into one another.

Certain forms of erythema, however, have sufficiently definite clinical characteristics to merit a descriptive epithet, although, as Osler pointed out, "they belong to one family and are characterised by the similarity of the conditions under which they occur; the frequency with which the lesions are substituted, the one for the other, in the same patient at different times; the tendency to recurrence, often through a long period of years; and, lastly, the identity of the visceral manifestations."

I shall here deal only with erythema multiforme, erythema scarlatiniforme recurrens, and erythema nodosum.

Erythema multiforme.—Although the individual lesions in this eruption vary considerably, the appearance of the more typical ones and their distribution are fairly characteristic, and diagnosis is usually easy. Most textbooks, in describing the ætiology, state that the eruption may occur as a result of the ingestion of certain foods and drugs, and after the administration of anti-toxic sera, or after vaccination. Personally I have never seen a really typical case associated either with the taking of food or drugs, or with the giving of sera. I believe that the classical type of the eruption, as described by Hebra, is rarely, if ever, due to the above causes, but is probably always of bacterial origin, the organism being in most cases a hæmolytic streptococcus, as in purpura hæmorrhagica. A tonsillitis of varying severity often precedes an outbreak of the eruption, and, although the association of erythema multiforme with that medley of infective symptoms we call "Rheumatism" may have been exaggerated, it has been sufficiently common in my experience to make me insist on every case that I see in a child or young adult being taken into hospital, watched most carefully for signs of endocarditis, and examined and treated for foci of infection. One of the most widespread eruptions of erythema multiforme that I have seen occurred in a boy with chronic rheumatic heart disease within a few hours of tonsillectomy, and the fact that the eruption recurs periodically in certain persons suggests that, like asthma and some forms of urticaria and eczema, it is an anaphylactic phenomenon.

I have recently had the opportunity of observing a case of recurrent erythema iris over a period of several months.

The patient is a young lady, and her first attack occurred some six years ago. The eruption is of the classical iris type, and appears chiefly on the backs of the hands and wrists, on the mucous membrane of the lips and tongue, and on the feet and ankles. At first the attacks recurred at intervals of about

three months, but when she came to me in December 1919 they were becoming more frequent. Her teeth are not obviously infected, but her tonsils, though small, are very scarred, chiefly as the result of an inadequate attempt to remove them in early life, and contain septic material. I discussed the advisability of enucleation of the tonsils with her, but she was anxious, if possible, to avoid this. I therefore asked Dr. Eyre to prepare a streptococcal vaccine from the septic material in the tonsillar crypts. This he did, and she was vaccinated over a period of ten months. During this time the attacks became less severe and less frequent, and finally ceased altogether, and she has remained well for about seven months since the vaccines were discontinued. Another attack, however, has recently occurred, and she has now consented to have the tonsils enucleated. The streptococcal vaccine used may have acted as a non-specific protein, but, if the enucleation of the tonsils leads to complete cessation of the attacks, I think we may fairly conclude that the erythema iris was due to infection from this source.

The blood destruction, with resulting anæmia, that occurs during an attack of erythema multiforme, probably depends on the hæmolytic properties of the infecting streptococcus. One significant fact is that, in six cases of erythema multiforme tested by Engman and Wander,¹⁶ the cutaneous reactions were all negative, but only food-proteins and not bacterial ones were used.

Erythema scarlatiniforme recurrens.—Scarlatiniform erythema may, of course, be produced by drugs, e. g. quinine, and a striking case in which the condition was due to this drug was shown by Dr. Graham Little before the Dermatological Section in July 1920: another similar case was shown some years ago by Sir James Galloway, the source of the quinine being a tonic aerated water. But the true recurrent form, which so closely resembles scarlet fever, like the typical recurrent form of erythema multiforme, would appear usually to be of infective origin, the active organism again being a streptococcus. Fatal cases have been recorded, and one such is described by Grindon,²¹ who gives a very complete *résumé* of the literature of the subject, but on his patient, unfortunately, no post-mortem examination was made. Hallopean and Tuffier²² observed a fatal case associated with rheumatism, pericarditis, and albuminuria. Two remarkable cases have been recorded, one by Sligh,²³ the other by Frank,²⁴ in which the eruption occurred on the same date every year, in Sligh's patient over a period of thirty-six, and in Frank's of twenty-six, years. It is probable that in these two cases the dates corresponded to the flowering of plants to whose pollen the patients had become sensitised.

I have seen one very characteristic example in a man who periodically developed acute generalised scarlatiniform erythema, followed by desquamation; the intervals between the attacks varied, but was usually about two months. He was treated by Dr. Eyre with streptococcal vaccine prepared from the gums and tonsils over a considerable period, apparently with complete success. Unfortunately, however, I have lost touch with him.

Erythema nodosum.—Much that has been said concerning erythema multiforme and erythema scarlatiniforme applies to this condition. Its association with rheumatic lesions, such as endocarditis and arthritis, is too common to be accidental, and there is no question that in children at any rate every case should be kept in bed, and the heart carefully watched. It has been said that it does not tend to recur, but I have seen a child with rheumatic heart disease in two separate attacks, and there was a history of a third. The majority of cases are, I think, unquestionably due to streptococcal infection, and Finger, quoted by Abt,²⁵ found streptococci in the inflammatory lesions. Rosenow²⁶ claims to have isolated from the nodules a polymorphous diphtheroid, closely resembling in some stages a streptococcus, and this he believes to be the causative organism. Stokes²⁷ considers that there are two groups of cases, (1) due to streptococcal infection, and (2) due to tuberculosis, and Landouzy describes a case in which he found a tubercle bacillus in a nodule, and was able to tuberculise a guinea-pig. One cannot help feeling that these cases associated with tuberculosis are possibly really examples of Bazin's erythema induratum. Levinsohn²⁸ has published a case of a lady who was subject to recurrent attacks of severe erythema nodosum over a period of many years. There was no evidence of tuberculosis, and the only focus of infection discovered was the teeth; treatment was undertaken with a stock vaccine containing 800 million streptococci and 400 million pneumococci to each cubic centimetre. A feature of the case was that at the sites of the vaccine injections swollen nodules of the erythema nodosum type appeared, and after a dose of 0.5 c.c. the reaction was so intense that suppuration was suspected, and the lesions on the legs were much aggravated. Eventually with smaller doses complete recovery ensued. The patient had not previously been entirely free from the eruption during a period of four years. Although in this instance the original source of infection appeared to be the teeth, the portal of entry in most cases is probably the tonsils and nasopharynx, as in rheumatic fever.

URTICARIA AND ANGIONEUROTIC ŒDEMA

Urticaria and angioneurotic œdema, which, as Osler says, is but urticaria "writ large," are the commonest cutaneous reactions in cases of protein-sensitisation, and in some instances, at any rate, the eruption is a true anaphylactic phenomenon. As an example, Schloss's classical case may be quoted.

A boy, aged eight, was extremely sensitive to eggs. When ten days old he had had an attack of diarrhœa, for which he was given the white of an egg in barley water, and no untoward symptoms occurred. When fourteen months old he was again given egg, and he at once developed urticaria and œdema of his lips and tongue. The cutaneous reaction towards egg-white was strongly positive. It is probable that the egg-white given in infancy was undigested and partly absorbed into the blood unchanged, and thus sensitisation occurred.

A Frenchman of my acquaintance was very fond of mussels, and for years ate them with impunity. One day he had rather more than usual, and within a few hours had violent diarrhœa and sickness, but no cutaneous symptoms. From that time, however, the taking of a single mussel has been sufficient to produce acute urticaria. In these two cases sensitisation has evidently occurred during life; in others susceptibility is apparently congenital or hereditary.

For a full discussion on food-sensitisation in urticaria and angioneurotic œdema, with reports of cases and references to literature, I would refer to papers by MacBride and Schorer,¹¹ and by Highman and Michael.¹⁴ Apparently in none of the reported cases of chronic urticaria, tested by them, were bacterial proteins used, and, although many cases of chronically recurring urticaria are due to an idiosyncrasy towards one or more food-proteins, there is, nevertheless, a very important group of cases, sometimes with angioneurotic symptoms, in which the toxic agent is evidently bacterial. These cases are commoner in women than in men, and the eruption is usually associated with symptoms of hyperthyroidism, namely, fullness or actual enlargement of the thyroid, flushing and excessive sweating on the slightest exertion, tachycardia, and the tumultuous action of the heart that occurs in true Graves' disease. The urticaria is usually apt to appear at night time, when there is frequently a slight rise of temperature, and can nearly always be provoked by undue exertion or excitement. The patients are often highly nervous and sometimes hysterical, and their urticaria, like the other symptoms, is often labelled a neurosis and left at that. But in most cases their symptoms of hyperthyroidism, their nervous irritability,

An elderly lady was referred to me by a colleague on account of a severe right-sided supra-orbital zoster. Ever since a fall two years previously she had suffered from intense neuralgia of the right side of the head, with cutaneous-hyperæsthesia so severe that she could not lie in bed on that side. She had also had an attack of right-sided facial paralysis, and she suffered from subacute rheumatoid arthritis. It seemed probable to me that all her symptoms were due to some chronic focal infection. X-ray examination showed no abnormality of the skull-bones, nor was there evidence of dental infection. On the other hand, her tonsils were extremely septic, it being possible to express foul liquid pus from both. Their enucleation was considered, but not carried out on account of her age. Mr. Zamora, however, applied as thorough local treatment as possible, and a swab was taken from them, which on culture gave a pure growth of a long-chained streptococcus. Immediately following this manipulation of the tonsils an acute attack of iritis occurred. A vaccine of the streptococcus was prepared and given, but with each dose a recurrence of the supra-orbital zoster took place, and her joints became more painful. The patient, however, continued her injections, and after a time the neuralgia almost entirely disappeared, her rheumatic pains were relieved, and her facial palsy became much less obvious; moreover, her general state of health has greatly improved, and she has put on weight. Quite recently a further course of vaccine was given, and again each injection provoked a recurrence of the zoster. In this case it seems clear that the neuralgia, the facial paralysis, the herpes zoster, the rheumatism, and the acute attack of iritis, were all due to streptococcal infection from the tonsils.

ECZEMA

I now come to the most difficult, though perhaps the most important, part of my paper. To what extent is that type of reaction of the skin, which we term eczema, due to protein-sensitisation and focal infection? After a careful study of this question I think we can already make a tentative, though probably accurate, ætiological classification of the various types of eczema that occur.

Infantile Eczema.—(1) That produced by external irritation and infection with pyogenic cocci.

(2) A type that is exactly comparable to true seborrhœic eczema of adults, and which is associated with an excessive carbohydrate diet, and increased alkaline tolerance: (1) is especially liable to arise in children subject to (2).

(3) That due to protein-sensitisation, usually to food-proteins.

Adult Eczema.—(1) That in which external irritants or infection with pyogenic cocci are the provoking causes.

(2) True seborrhœic eczema, which is quite distinct from

seborrhœic dermatitis, although the two may coexist. It is associated with a definite seborrhœic state, increased alkaline tolerance, and in some cases a high blood-sugar.

(3) That due to protein-sensitisation.

(4) A type, which occurs most commonly on parts exposed to light, and which is associated with excessive intestinal putrefaction and indicanuria.

We are only concerned with types (1) and (3).

Eczema Due to External Irritants.—A whole book could be, and indeed has been, written on this subject, which is one of the most fascinating in dermatology. I shall only attempt to emphasise a few important points. There are, of course, some irritants which will produce acute eczematous dermatitis on practically every skin, but on the other hand we see that, as in the case of susceptibility to foreign proteins and drugs absorbed from within, some persons seem to have an inborn intolerance of certain substances applied externally, and in others such intolerance is evidently acquired.

It is common knowledge that in certain trades a person may be exposed for years to an irritant without ill-effect; then suddenly his resistance breaks down, and an acute dermatitis results. In many cases subsequent exposure to the irritant, even in small quantities and for a short time, will always cause a recurrence of the dermatitis, although in others tolerance is re-acquired. Thus a surgeon used lysol for years with impunity; he then suddenly developed an acute eczema of his hands and forearms. He avoided this particular antiseptic afterwards, until one day he inadvertently rinsed his hands in a bowl containing it. Immediately another attack of dermatitis followed, and he was forced to abandon his work for several weeks. Acute eczema, at times confined to the face and neck, but sometimes generalised, is not uncommonly produced by a certain hair-dye containing paraphenylenediamine, although the victims may have previously employed this dye for a long while without untoward result. Fordyce³¹ records a case of this kind, in which the dermatitis lasted for two months, during part of which time there was considerable pyrexia; a point of great interest in his case was that there was a leucocytosis of 30,000 with an eosinophilia of 30 per cent. Mook³² has reported a case of dermatitis in a dentist due to apothesine; cutaneous tests to this substance and to procain were positive. Guy Lane³³ reports three cases of a similar nature, all in dentists, in which susceptibility to procain was acquired after some months' use of the drug: in all three patients positive cutaneous reactions were obtained.

As has been said, it is difficult to bring these cases of sensitiveness towards drugs and non-protein irritants into line with susceptibility towards proteins, since a true anaphylactic reaction is only supposed to be possible with protein bodies. It has been suggested that drugs, etc., combine with the body-proteins, and that it is towards these compounds that susceptibility occurs; there is certainly evidence in favour of this view in the case of salvarsan. However this may be, the phenomena of idiosyncrasy towards drugs, chemicals, etc., and towards proteins are so similar that they may all be conveniently termed "anaphylactoid," and it should be particularly noted that positive cutaneous reactions can be obtained with both protein and non-protein substances.

An interesting case of "baker's eczema" has recently come under my care. The eruption, when present, is confined to the hands and forearms, the parts with which the flour comes into direct contact. The cutaneous reactions are strongly positive to wheat leucosin and globulin, but negative to gliadin and glutenin. The patient exhibits the phenomenon of local sensitiveness of his skin, since flour bandaged on his forearm, when he is free from the eruption, causes itching, and later an eczematous dermatitis, whereas when applied to his leg it is without effect.

Reference must be made to a condition known in America as "infectious eczematoid dermatitis," and a paper by Sutton³⁴ concerning it is of considerable interest. He points out that it follows as a rule some suppurative condition, such as scabies, furunculosis, and infected wounds, and in over 25 per cent. of his cases the eczematoid eruption was accompanied by urticarial lesions. Engman and Wander¹⁶ report what was apparently a case of this kind in a young girl of sixteen, who had relapsing attacks of eczema for some years. A cutaneous test was positive to *Staphylococcus aureus*, and she was successfully desensitised by a vaccine. I have had cases under my own care which proved very obstinate to local treatment, but in which a staphylococcal vaccine was rapidly successful. It is probable that patients who develop this form of eczematoid dermatitis have become sensitised to the *Staphylococcus aureus*, and that the eruption depends on this sensitisation.

Eczema due to protein-sensitisation.—We will consider first infantile eczema. In infants there are two main types of eczema, apart from that produced by external irritants, and it is the failure to recognise this fact that has made infantile eczema "the *bête noire* of all dermatologists," as Engman and Wander express it. There is first the type that is so common

in the out-patient department of hospitals in poor districts, and which corresponds to true seborrhœic eczema in adults. It affects the scalp, the post-auricular regions, the face around the nose and mouth, the neck, and the flexures. Its onset is often sudden, and oozing takes place very rapidly, so that secondary infection occurs early, resulting in impetiginisation. This condition, as with the impetiginised seborrhœic eczema of adults, is often wrongly diagnosed as impetigo contagiosa, and surprise is expressed at the unsatisfactory results obtained when the orthodox treatment for that disease is adopted. This form of eczema is apparently associated with excessive carbohydrate feeding.

In early cases correct treatment is rapidly successful. A purge, large doses of alkali, and temporary abstention from carbohydrate food, together with the local application of a soothing lotion are all that is necessary. In cases, however, which are neglected or wrongly treated, secondary infection with pyogenic cocci occurs, and children are seen in which a persistent impetiginised eczema of the scalp and ears, associated with chronic blepharitis, has lasted for years. In these chronic cases the secondary infection is more important than the underlying eczema, and I have had brilliant results by means of vaccine therapy when all forms of local treatment and internal medication have been tried in vain. Control of the diet and attention to the nose and throat are also important.

In the second variety of infantile eczema the clinical picture is quite different, and it is usually possible to distinguish between the two at a glance. It is this type which is probably always due to susceptibility towards one or more foreign proteins, usually, of course, those of food-substances. These children on the whole conform to a definite type. They are, even in early infancy, emotional and *difficile*, but withal charming and abnormally intelligent. In later life they are apt to become asthmatic. As regards their skin, it will be found that it is often slightly, sometimes definitely, ichthyotic, and I am convinced that ichthyotics are not only abnormally susceptible to external irritants, but are also frequently subject to anaphylactic eczema and asthma.

Apart from its dryness, the skin of these children feels thickened, and has a peculiar yellowish or *bistré* colour, and there is often hyperkeratosis around the pilo-sebaceous follicles. The eczema takes the form of diffuse scaly patches, which become markedly thickened: they are situated on the forehead, the cheeks, the extensor surfaces of the limbs, particularly around the wrists, the trunk, and sometimes in the flexures.

Oozing does not readily occur, although it is often provoked by scratching, nor is secondary impetiginisation nearly so common as in the first type. One very characteristic feature is that the eczematous patches may become quite pale and almost invisible in the course of a few hours, only to flare up when a paroxysm of itching, or a fit of crying, occurs. This is not the case in the first type, in which, too, the itching is not so intense. In both types the eczema is apt to be accompanied by nasopharyngeal and bronchial catarrh, but in the first the catarrh tends to be persistent, whereas in the second it waxes and wanes *pari passu* with the intensity of the eczema. It is this second type which corresponds to Czerny's description of the "exsudative diathesis," although later observers, myself included, have confounded the two types. Probably most of the symptoms which Czerny described as characteristic of his exsudative diathesis are manifestations of protein-sensitisation.

Engman and Wander¹³ found that of the exsudative type 78 per cent. responded positively to some protein-sensitisation; of the remainder probably some were wrongly included in the exsudative group, or the protein to which they were susceptible was not discovered. In those cases in which control of the diet could be maintained brilliant results followed. The most striking case they record was that of a girl aged 3 in whom the eczema began shortly after birth. "The skin of the face and extremities was thickened, yellow, pasty, and showed patches of eczema. The glands at the angle of the jaw and in the neck were enlarged. The child was a mouth-breather, a condition which would probably continue for years unless the cause was discovered and eliminated. The child proved distinctly reactive to wheat. Fortunately, in this instance, they had the co-operation of a very intelligent mother. The baby appeared for treatment on April 2, 1919, and was completely well on May 23, 1919. She was presented at the joint meeting of the Chicago and St. Louis Dermatological Societies in October 1919, and not the slightest symptoms of her former disease were to be found. The enlarged glands had disappeared, her skin was soft, pink, smooth, healthy, and beautiful. Strange to say, even the mouth-breathing had disappeared. The mother stated that if the child was given a cracker, for instance, for breakfast, in the afternoon she would begin to scratch and rub her skin because of erythematous welts that appeared on the cheeks and extremities."

Although in children it is to food-proteins that susceptibility is often observed, in a few cases, as in asthma, the offending

protein may be bacterial, and Whitfield³⁵ describes the case of a child aged three years who suffered from eczema and spasmodic cough. These were relieved by removal of septic tonsils and adenoids. It is possible that in this case the child was primarily susceptible to one or more food-proteins, and became secondarily sensitive to the bacterial infection of its respiratory tract.

Eczema of Adults.—As might be expected, eczema in adults is far less likely to be due to food-sensitisation than is the case in children, since complete or partial tolerance to foods is usually gradually acquired as the child grows older. Howard Fox and Fisher³⁶ conclude that only a small proportion of eczema in adults is due to this cause. They quote the case of a man with chronic eczema of the hands and wrists who gave a positive reaction to cabbage; abstention from cabbage and *Sauerkraut* resulted in the disappearance of his eczema, which reappeared at once when the forbidden vegetable was again eaten. Ramirez¹⁵ comes to the same conclusion, namely, that anaphylactic eczema, like asthma, is commoner under the age of thirty. Engman and Wander¹⁶ report some striking cases in their series, including one patient who was sensitive to oak pollen, and had suffered from erythematous eczema from this source for nine years. It began in April, lasted through the spring, and was accompanied by hay-fever. Relief was obtained by desensitisation.

There is no question that some cases of chronic eczema in adults are directly or indirectly due to focal infection, particularly oral sepsis, and Ehrmann used to lay stress on the association of eczema and chronic appendicitis. In my experience that type of eczema termed "nummular," which begins by multiple discoid patches situated most commonly on the backs of the hands, wrists, and forearms, and on the extensor surfaces of the thighs and legs, is a frequent concomitant of oral sepsis, and I have had several cases during the past few years, which cleared up when this was dealt with, and in which other methods of treatment had proved only palliative. I may mention one case of this sort of peculiar interest, that of a woman who had suffered from eczema of her arms and legs for years. She had severe oral sepsis, and following the extraction of her teeth, her eczema, after temporarily becoming much worse, rapidly cleared up entirely. A few months later she reappeared with generalised scaly eczema of her face, neck, and trunk of several weeks' duration. I examined her cutaneous reactions, and found that she gave a very strong positive reaction to oat-protein. She then told me that since her teeth had been

removed she had eaten large quantities of porridge, although she had never previously done so. She was advised to give up porridge, with the result that her eczema disappeared in about a week.

LUPUS ERYTHEMATOSUS

This condition, which must, I think, be held to be very closely allied to erythema multiforme, is still regarded by many dermatologists as a tuberculide. During the past two years and a half I have collected a considerable number of cases of the disease, most of which I have been able to investigate thoroughly, and to keep under observation. In none of them was there any evidence of active tuberculosis, and in only four was there reason to suspect former tubercular infection sufficient to produce clinical manifestations, such as cervical adenitis, and the so-called tubercular stigmata. On the other hand, in every one of my cases one or more definite foci of infection were present; in some there was severe oral and tonsillar sepsis, in others the tonsils were badly infected without oral sepsis being present (although in most of these infected teeth had already been removed), and in others, in addition to these two foci, a *streptococcus longus* was easily recoverable from the faeces.

A striking and important feature of my series of cases has been the frequency with which the disease has been accompanied by definite arthritis, or by complaint on the part of the patients of attacks of "rheumatism" in the joints and muscles. Two of my patients have severe rheumatoid arthritis of the type that is associated with chronic streptococcal focal infection, and Dr. N. Mutch has kindly given me notes of four cases that have come under his own observation, in which lupus erythematosus was present. In one, which I saw personally, a typical patch of lupus erythematosus developed while the patient was having streptococcal vaccine injection for his arthritis. In none of these is there the slightest indication of tuberculous infection.

Another point in favour of lupus erythematosus being due to focal streptococcal infection is the extraordinary susceptibility of most of the cases to autogenous streptococcal vaccine; some of my patients have had very severe reactions, both general and local, accompanied occasionally by a rapid temporary spread of the eruption, with quite small doses. In two cases an acute exacerbation of the disease, accompanied by high fever lasting several days, and a generalised spread of the rash as an acute erythema, occurred twenty-four hours

after an overdose of vaccine, and in both cases with the subsidence of the fever, both the recent erythema, and much of the original eruption, disappeared. This question of focal reaction is important, for, although reactions may occur in these cases to a certain extent when any non-specific protein, or even drugs, such as arsenic, are injected, they are in no way comparable to those produced by streptococcal vaccine. To test this point, I injected a patient, who was extremely sensitive to his own vaccine, with large doses of staphylococcal and pneumococcal vaccine, and although these produced a feeling of *malaise*, the focal reaction was negligible.

As regards the treatment and prognosis of this disease, my observations go to show that what is true for rheumatoid arthritis is true for lupus erythematosus. That is to say, foci of sepsis must be sought for and dealt with, and afterwards cautious autogenous vaccine treatment carried out. In early cases removal of the primary foci of infection, with or without subsequent vaccination, has given most gratifying results. In patients in whom the disease has been present for several years the same success has not been obtained, probably because secondary foci exist, such as the intestines and lymphatic glands, but even the most chronic and obstinate cases have shown steady improvement. I entirely agree with Dr. Adamson that prolonged rest in bed, with careful dieting and attention to the gastro-intestinal functions is of paramount importance in the treatment of these severe cases of long standing, but, unfortunately, this is not always practicable.

One typical case was an asylum nurse, and the eruption, which was of many years' standing, involved the nose and the greater part of both cheeks. She had severe oral sepsis, and her tonsils were large and contained pus. After removal of the teeth and tonsils, there was considerable immediate improvement. She has since been given autogenous streptococcal vaccine by Dr. Eyre, with the result that the greater part of the eruption has gradually disappeared, and in a few months she will probably be cured, although there will be considerable scarring. There is no evidence of tuberculous infection, and she has had no treatment except the removal of the teeth and tonsils, and subsequent vaccination.

Most dermatologists agree that lupus erythematosus and erythema multiforme are closely allied conditions. The latter is often associated with that transient form of arthritis which we call acute rheumatism, and, although liable to recurrence, neither the skin eruption nor the arthritis is followed by permanent fibrotic change. In lupus erythematosus, on the other

hand, although the lesions may disappear entirely without leaving a trace, the more chronic patches are followed by scarring, just as permanent deformity of the joints results from a chronic rheumatoid arthritis. In my opinion lupus erythematosus bears the same relationship to rheumatoid arthritis that erythema multiforme bears to the acute rheumatism of children and young adults.

Apart from infection, two other factors must be considered which often seem to determine the localisation of the eruption; one is the action of light, and the other a feeble peripheral circulation. In some patients exposure to strong sunlight will not only aggravate existing patches, but will also cause new ones to appear; the Finsen light has the same effect. On the other hand, in persons with a "chilblain" circulation, the eruption tends particularly to involve the extremities and the tips of the nose and ears; in warm weather patches on these parts may disappear entirely, only to return with the approach of winter.

The more cases I see of lupus erythematosus the less do I believe in the view that it is a tuberculide, and Cranston Low and Rutherford³⁷ have published the results of a post-mortem examination on a fatal female case, in which absolutely no trace of tuberculosis could be found. There had been, however, severe oral sepsis, and a *Streptococcus longus* and *B. Friedländer* were recovered also from her sputum.

DERMATITIS HERPETIFORMIS

The actual cause of this intractable condition is entirely unknown, although the periodic outbreaks of the eruption, and the eosinophilia accompanying them, suggest that it belongs to the anaphylactoid group of diseases. Engman and Wander¹⁶ did cutaneous tests on eleven typical cases without definite result, but they do not state whether they used bacterial proteins. Engman and others have emphasised the association between intestinal putrefaction and the disease, but although indicanuria has been present in some of my cases, it is not an invariable accompaniment. Other observers have stated that the stools usually show absence of *B. coli*, but this is certainly not always true. Howard Fox³⁸ showed a female case in which there was no evidence of focal infection of the teeth and tonsils, and the cutaneous reactions to twenty-six proteins were negative, except for cocoa and corn-starch, but the stools were highly acid, and coli bacilli were absent. She was given alkaline enemata and *B. coli* were implanted, but without result up to the time of demonstration. Whitfield³⁹ mentions

a case in which all investigations were completely negative, and he has used faecal vaccines without any benefit. Davis ⁴⁰ has reported temporary cure by injections of emetin, but there were relapses.

In spite of Whitfield's failure with faecal vaccines, I have tried Danysz's method in two cases with very satisfactory results. One was a boy of eight years who was said to have had the rash since the age of six months. He was artificially fed from birth with Mellin's food. Practically the only time he had been entirely free from the rash since its beginning was when he had scarlet fever at the age of seven and a half. He had seen a distinguished dermatologist who had diagnosed dermatitis herpetiformis, and when I saw the boy last October the eruption was extensive and quite typical. Large doses of arsenic had been given without much benefit. After two courses of twelve injections of a vaccine, prepared from the faeces according to Danysz's method, the rash disappeared, and he has remained completely free, but, of course, this may be only a temporary result. At the same time, since other methods of treatment are so unsatisfactory, I think it is worth while to give this method a trial.

PSORIASIS

There is at present no definite evidence of any constant connection between psoriasis and either protein-sensitisation or focal sepsis, and the aetiology of the disease remains unsettled. Some think that eventually some specific organism will be discovered to be the cause. It seems to me, however, that certain features of the disease suggest rather that, like eczema, it is a form of reaction of the skin, rather than a disease *sui generis*. That it is hereditary in a considerable proportion of cases is unquestionable, and this fact, perhaps, brings it into line with asthma and the anaphylactic type of eczema. Another point of resemblance to eczema is that, should a person subject to psoriasis contract scabies, even though at the time of infection his skin be entirely clear, an outbreak of his psoriasis will almost inevitably occur, and the distribution of his eruption will follow that of scabies. It also, of course, occurs at the site of operation scars. Danysz describes a remarkable case of the disease in which a profuse outbreak followed the painting of the skin with iodine, and when this was recovered from, further attacks could always be provoked either by the external application of iodine, or the taking of potassium iodide by the mouth, and I have recently seen what I believe to be a similar case. Dermatitis herpetiformis can also apparently be pro-

voked by iodides in persons subject to the disease. These, and other facts, suggest that the predisposing cause of psoriasis is not always the same, but, as in asthma and urticaria, differs in different subjects.

I have myself been struck by the fact that, among psoriasis patients, two main types can be distinguished: the fair-haired, fresh-complexioned type, in which the eruption often breaks out suddenly, like an exanthem, in the acute guttate form after an attack of tonsillitis or nasopharyngeal catarrh, and the dark, sallow type, in which it is more likely to occur in diffuse sheets rather than in circumscribed patches, and in which the characteristic heaped-up silvery scales are less evident than in the other type. Although the distinction between these two types is by no means absolute, it is a useful one clinically. With regard to the first, Winfield⁴¹ quotes six cases, in one of which psoriasis developed for the first time after an operation for tonsils and adenoids, and in five the eruption followed acute follicular tonsillitis.

In patients belonging to the second type (and sometimes in those of the first) there is often evidence of excessive intestinal putrefaction, with indicanuria, and Whitfield⁴² has shown that it is in these cases that the administration of creosote internally will cause the eruption to disappear.

Adamson,⁴³ in a very thoughtful and convincing article, has recently suggested that keratoderma blenorrhagica is really psoriasis in a person with chronic gonorrhœal infection, and that psoriasis may be "due to a micro-organism bearing some family relationship with the gonococcus." Although I am inclined to believe his first contention, the explanation I would offer is that in a person with a tendency to psoriasis, gonorrhœal infection is capable of provoking the eruption, and that if this infection can be overcome by gonorrhœal vaccine, the psoriasis will disappear. I have recently seen a case which impressed me very much. A man came to me with an extensive eruption of typical psoriasis, involving practically the whole body, including the face and scalp. Careful examination showed that he had "snail-track" syphilitic lesions on his fauces and a single ulcerating syphilide on his scrotum. He admitted having had syphilis a year previously, with a rash "quite different from the present one," for which he had been insufficiently treated. There was no doubt that, with the exception of the single lesion on the scrotum, the present eruption was true psoriasis and not a psoriasiform syphilide. He was given 0.9 neo-salvarsan intravenously and mercury and iodide by the mouth, but no local treatment. Within a

few days there was a most astonishing change in the psoriasis; the scaliness disappeared at once, and at the end of a fortnight not only had the lesions of the serotum and fauces healed, but the psoriasis had almost completely faded. In ordinary cases of psoriasis the action of salvarsan is uncertain and of doubtful value, and at any rate never produces the dramatic effects that were seen in this patient. I think it reasonable to suppose that in this case we were dealing with a psoriatic in whom an outbreak of the eruption had been provoked by the syphilitic infection.

Whether psoriasis is ever due to sensitisation towards food-proteins I do not know, although I have performed cutaneous tests on a few patients with negative results.

I am, then, inclined to the following conclusions—

(1) That psoriasis is not due to any one specific infection, but that, like eczema, it is, as Brocq has suggested, a form of cutaneous reaction, and may be provoked in those subject to it by a variety of causes. (2) In some cases the provoking cause is an external one, *e. g.* infection with scabies or trauma from injury or operation. In others it is an acute or chronic infection, *e. g.* tonsillitis, and more rarely gonorrhœa and syphilis, and in others probably intestinal toxæmia, as evidenced by indicanuria, is responsible. Unsatisfactory as this view may seem, it merely brings psoriasis into line with eczema, a condition which we know to depend on a multitude of causes both internal and external.

LICHEN PLANUS

We have no more exact knowledge of lichen planus than we have of psoriasis, but every one is agreed that it is most commonly seen in persons who, as the result of worry, sorrow, overwork, or chronic toxæmia, are in a state of nervous exhaustion. The fact, too, that in acute cases lumbar puncture and the withdrawal of a small quantity of cerebro-spinal fluid will relieve the subjective symptoms and apparently hasten the disappearance of the eruption, suggests that the nervous system is in some way involved in the production of the disease, but this is little more than conjecture. In some cases, removal of some source of infection, such as dental abscesses, has been followed, even in long-standing cases, by the rapid disappearance of the eruption, but, on the other hand, cases are met with in which no focus of infection is discoverable, and although most persons with lichen planus are obviously not fit, I have seen it in a man who was apparently in perfect health and in the best of spirits.

ALOPECIA AREATA

In a previous paper I⁴⁴ have expressed my conviction that in most cases alopecia areata is due to focal infection, usually in the mouth or throat, and subsequent experience in cases of this very common disease has materially strengthened this view. Whether the bacterial toxins act directly on the hair-papillæ, or indirectly through the nervous system, it is difficult to say, but Whitfield's⁴⁵ observation, that in a few cases in adults eyestrain would appear to be the provoking cause, suggests the latter view. Jacquet, of course, attributed most cases of the disease to reflex irritation usually from the teeth or nasopharynx. Whitfield,⁴⁶ who holds the trophoneurotic theory of the disease, states that it was much commoner during the war, so much so that the name "alopecia airrader" was suggested. Although I do not deny that mental shock or intense fear may produce rapid blanching and even a sudden and complete fall of the hair, my experience was that ordinary alopecia areata was uncommon among the troops until after the influenza epidemics. It may be remarked that Graves' disease, which is not uncommonly associated with alopecia areata, may come on acutely after a severe shock or sudden terror, and yet in a certain number, if not in most cases of this disease of gradual onset, the cause is probably a chronic focal infection, particularly it would seem in the tonsils.

The chief arguments that I would adduce in favour of my view are as follows—

(1) Acute infections, such as erysipelas, influenza (particularly if accompanied by virulent streptococcal infection, as was the case in the war epidemic), and typhoid, are often followed by severe loss of hair, and after erysipelas and influenza I have seen typical patches of alopecia areata accompany the diffuse fall on other parts of the scalp. If it be admitted that an acute infection may cause the disease, it is reasonable to suppose that it may result from a chronic infection.

(2) In cases of alopecia areata of many years' standing I have been able to bring about a complete regrowth of hair after removal of a chronic focus or foci of infection and subsequent vaccine treatment. The following case, which was shown before the Dermatological Section of the Royal Society of Medicine, is a case in point.

In a boy, aged twelve years, bald patches began to appear on the scalp at the age of seven. Within a few months practically the whole scalp was bald except for a fringe round the lower

margin. At times growth of lanugo hair would appear and then this would fall again. He came under my care early in 1920. At that time there was almost complete alopecia except for a fringe of downy hair around the lower margin of the scalp. There was chronic rhinitis, the tonsils were enormously hypertrophied, almost meeting in the middle line, and the posterior nares were blocked by a mass of adenoids, from which there was a constant muco-purulent discharge. The boy was admitted to hospital, and the tonsils were enucleated and the adenoids removed by Mr. Zamora on February 24, 1920. Cultures from the enucleated tonsils gave principally a growth of *Streptococcus pyogenes longus*, from which a vaccine was prepared and administered for about five months. By April 13 the hair was growing freely, and there was eventually a complete re-growth of normal hair.

Another case of complete alopecia of the scalp, eyebrows, and eyelashes of over three years' duration was also subject to asthma. Removal of very septic tonsils, followed by the administration of streptococcal vaccine prepared from them, has resulted in the cessation of the asthmatical attacks, and new hair is now beginning to grow on all the bald parts.

(3) Apart from oral sepsis and chronic tonsillar and nasopharyngeal infection, which are so common that their association with alopecia areata might be held to be accidental, I have now seen three cases accompanied by nasal sinus suppuration in which re-growth of hair took place after the sinus infection was dealt with.

(4) The appearance of a new patch or patches sometimes coincides with an acute exacerbation of infection, *e. g.* a severe cold or an attack of tonsillitis in cases of chronic nasopharyngeal or tonsillar sepsis. In some of my cases in which re-growth of hair occurred rapidly after the removal of septic tonsils and adenoids, a fresh patch has appeared after a severe cold, but in all these rapid recovery took place.

To sum up, alopecia areata is a symptom and not a disease due to one definite cause (typical exclamation-mark hairs, of course, occur frequently on the scalp after x-ray treatment for ringworm, and a patch of alopecia may result from injury to a nerve). A few cases are probably due to infection of the hairs with a fungus; these seem to be commoner in France than in England, and some of the epidemics of the disease reported were probably due to this cause. In adults eye-strain is apparently occasionally responsible, and complete alopecia may occur suddenly as a result of mental shock or fear. But, apart from these exceptional cases, I believe that in the vast majority the cause is an acute or chronic infection.

In children and young adults the tonsils and nasopharynx are the most likely source of infection; in adults many cases are associated with oral sepsis, but other sources must always be considered, such as the tonsils and nasopharynx, the nasal sinuses, and, perhaps, the appendix or intestines. The actual infecting organism responsible is probably usually, if not always, a *Streptococcus longus*.

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TESTS FOR PHYSICAL EFFICIENCY *

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PART I.

DURING the War considerable attention was devoted to the estimation of a man's physical efficiency. The question became increasingly important in the later years, for owing to the shortage of man-power it became a matter of urgent necessity to find some means of estimating more accurately than had hitherto been possible the physical capacity of each individual, in order to find out what work he was capable of undertaking and thus make the best possible use of him.

Although the stress of war gave prominence to the question, it has always been before the medical profession in the examination of recruits for the Services, athletes and candidates for life insurance. At the present time there is great need of reliable tests for physical fitness in connection with the assessments made by Pension Boards. In the diagnosis and treatment of disease tests for physical efficiency have been, and always must be, essential for guidance. Take, for example, a patient with heart disease; various influences may cause a breakdown of compensation, but the most potent is physical strain greater than the patient's heart is capable of bearing. "Don't do anything that causes you distress or shortness of breath," the advice usually given to such a patient, is admirable as far as it goes, but it leaves the meaning of distress and shortness of breath to be interpreted by the patient, and if his interpretation differs widely from that of the physician, he may restrict himself unduly or, on the other hand, attempt an amount of exertion that will seriously damage his heart. This danger was well illustrated in the case of a nurse suffering from mitral stenosis, who was seen by one of us (G. H. H.) recently. She stated that she could walk $2\frac{1}{2}$ miles an hour without any difficulty, but that on going uphill she was rather short of breath. She was made to walk 300 yards at her usual pace, and on returning was obviously dyspnoic, but in answer to the question, "Does that make you

* Expenses in connection with this research were defrayed in part by a grant from the Medical Research Council.

short of breath," replied, "Not at all." If such a test of efficiency had not been made the usual advice in this case would quickly have been followed by a breakdown of compensation, simply because the patient, in spite of her training as a nurse, had no idea of the meaning of shortness of breath.

But the knowledge of a patient's physical efficiency is of value not only in treatment, but also in diagnosis; we are all familiar with the difficulties met with in the diagnosis of early phthisis. In cases where there is any progressive disease of the lung, all the evidence available indicates that the response to exercise is abnormal, and it would therefore appear that a normal reaction to exercise excludes the presence of active disease.

Physical efficiency is a complex in which many factors are concerned, and it is necessary to recognise that it is relative to the conditions to which the subject is exposed; a man may be physically fit for service in the infantry or artillery, but not as an airman. The need is for a test of the general physiological condition, and this is found in the response to the influence of muscular work, which demands an adjustment of respiration, circulation, and glandular activity to meet the needs of the muscles; the co-ordination of these systems is carried out by the nervous system. The test must be such that it can be applied generally to all classes and the muscular work must not be specialised. For this reason the forms of exercise in daily use by all people, such as walking or going up stairs, are the most suitable. The advantage of the latter is that the minimum of work can be correctly calculated from the weight of the subject and the height of the ascent; further it is possible by altering the number of steps and the rate of ascent to grade the work done.

If it be granted that the muscular test is the best, the method of application must be standardised as far as possible. The condition at rest before exercise, the response to a given exercise and the return to the condition at rest must be determined. It is obvious that the greater the number of the systems of the body tested the better, but in practice time must be saved in the examination. For many reasons the pulse affords the best indications, and it will be useful to consider these in some detail, and in a later paper to criticise the other methods, relating to respiration and other systems, which have been employed as tests of efficiency.

The heart, as a pump, must be adjusted to the general needs of the body; its action will indicate the nervous control, the tonic restraining influence of the vagus nerve, the accelerating effect of the sympathetic nerve, and the response to changes of tension of its muscular fibres produced by the filling of its

chambers with blood. In addition chemical changes in the composition of the blood can affect the heart directly or indirectly through the nervous system, and the temperature of the blood also has definite effects. Without an efficient circulation of blood through the lungs an adequate intake of oxygen and output of carbon dioxide are impossible; the circulation and respiration must be co-ordinated.

The efficiency of the human body as a machine has been studied especially by Benedict and Cathcart,¹ who determined the relation between work and respiratory exchange, *i. e.* between work and the combustion in the body. The mechanical efficiency (E) of the body can be estimated in this way, for $E = \frac{a \times 100}{b}$; the actual work measured being represented by (a) and the total expenditure of energy by (b). In the trained man these observers found that the average efficiency was greater than that of ordinary subjects and the maximum net efficiency reached a value never attained by the untrained; the optimum efficiency was reached when the speed of the exercises was moderate.

Such determinations as the above are beyond the resources of ordinary clinical laboratories, and for this reason it is necessary to show how the pulse can be safely employed as the indicator. The general results of a series of investigations by various observers have shown: (1) that the consumption of oxygen varies almost directly with the work done by the subject, (2) that the ventilation of the lungs varies with the consumption of oxygen, (3) that the output of blood by the heart runs parallel with the consumption of oxygen, and (4) that there is within limits a close association of the output of blood by the heart with its rate of beat.

In the first place the pulse-rate when the subject is at rest must be considered. The pulse of healthy men at rest shows a considerable range, as shown by the following figures:—

Subjects.	Range of Pulse.	Number of observations and cases.	Authority.
Men . . .	45-90	—	Guy ²
„ . . .	44-80	45	Miss Buchanan ³
„ . . .	47-90	62 on 35 men	Cook and Pembrey ⁴
„ . . .	55-[112 *]	162 on 38 men	G. H. Hunt ⁵
„ . . .	52-104	108 on 9 soldiers	Parker and Pembrey ⁶
Women . . .	60-99	54	Misses Hartwell and Tweedy ⁷
„ . . .	60-96	55	Miss Surie ⁸

* This man's pulse-rate was unusually high, but as he was a perfectly fit man, playing games regularly, we feel he should not be excluded.

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There is definite evidence to show that in any particular person the pulse-rate is slower the better his physical condition. Michell examined a large number of undergraduates at Cambridge, including 1200 rowing men, 410 football players and a few running men; he found for the average rates of the pulse the following values; in the first year of residence, 69, second year 64·5 and third year 56·8.

Other results confirming this conclusion are given in the following table :—

Subjects.	Pulse.		Number of observations and cases.	Authority.
	Range.	Average.		
Men Trained . . .	55-73	69·6	14 on 5	G. H. Hunt
„ Untrained . . .	60-96	78·1	53 on 16	
Women Athletic Students . . .	—	76	on 16	Misses Hartwell and Tweedy
Women Non-Athletic Students . . .	—	78	on 38	

We may assume that the speed-limit of the ventricles in the normally acting heart is in the neighbourhood of 180, and the slower the pulse-rate at rest the greater the possible variation available for increased muscular work; hence the advantage to the athlete of a slow pulse at rest. Infections of the heart muscle and diseases such as phthisis which lower a man's efficiency may cause a permanent increase in his pulse-rate. As a general rule then a man's pulse-rate at rest, taken of course under constant conditions, gives us some indication of the variations in his physical fitness from time to time.

The pulse-rate at rest gives us less assistance in comparing different men than in comparing the condition of the same man at different times, and the reason of this is found, as already shown, in the great variation in the pulse-rates of perfectly healthy persons.

Although it is true that the slower the pulse the fitter the man, there are exceptions to this rule, and any conclusions as to a man's fitness based on his pulse must be checked by other evidence.

The effect of exercise on the pulse-rate gives us a much better idea of a man's efficiency than his pulse taken at rest. If a trained athlete and a man unaccustomed to physical exercise do the same amount of muscular work, the pulse-rate of the latter increases more and returns more slowly to its original

rate than that of the former. This is illustrated by the following figures :—

	Pulse-rate at rest.	Pulse-rate directly after exercise.	Time of return to original rate.	Authority.
Trained Men . . {	76	110	1½ minutes	G. H. Hunt
	78	114	1 minute	
Untrained Men . {	88	150	Did not return	
	86	130	in five minutes	

The effect of training on the same men is shown by the following results :—⁶

Subjects.	Load in kilos.	Increase in Pulse.			Exercise.
		Maximum.	Minimum.	Average.	March of seven miles.
P. { Untrained . . .	0	70	—	—	—
	0	72	—	—	—
	7	28	—	—	—
	14	40	—	—	—
Four Soldiers { at beginning of series of marches	2	48	40	43	—
	7	26	20	22	—
	14	40	16	24	—

Although it is certainly true that the pulse returns after exercise to its original rate more quickly in the “trained” man than in the untrained, there are the two following objections to using this alone as a means of comparing the two groups.

(1) It is difficult to estimate exactly the time taken for the return of pulse-rate.

(2) It leaves out of consideration the fact that the increase in pulse-rate after exercise is greater in the “untrained” than in the “trained” man.

These two objections need to be considered in detail :—

(1) This is best explained by a consideration of the effect of three different exercises A, B, and C* on the same individual as shown in Fig. 1. It will be seen that in the easiest (exercise A) the pulse returns to its original rate within half a minute, then falls below and remains below until the beginning of the fifth minute, then rises above for three and a half minutes,

* The amount of work done in exercise A was 1492 kilogrammetres, in exercise B 3730 kilogrammetres, and in exercise C 5476 kilogrammetres. Each exercise lasted two minutes. 1 kilogrammetre = 7·2 foot pounds.

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and finally returns to its original rate at the end of the eighth minute. Represented graphically the pulse-rates after exercise thus form a curve having the shape of the letter "S" placed horizontally, with the lowest part of the curve occurring during the second minute.

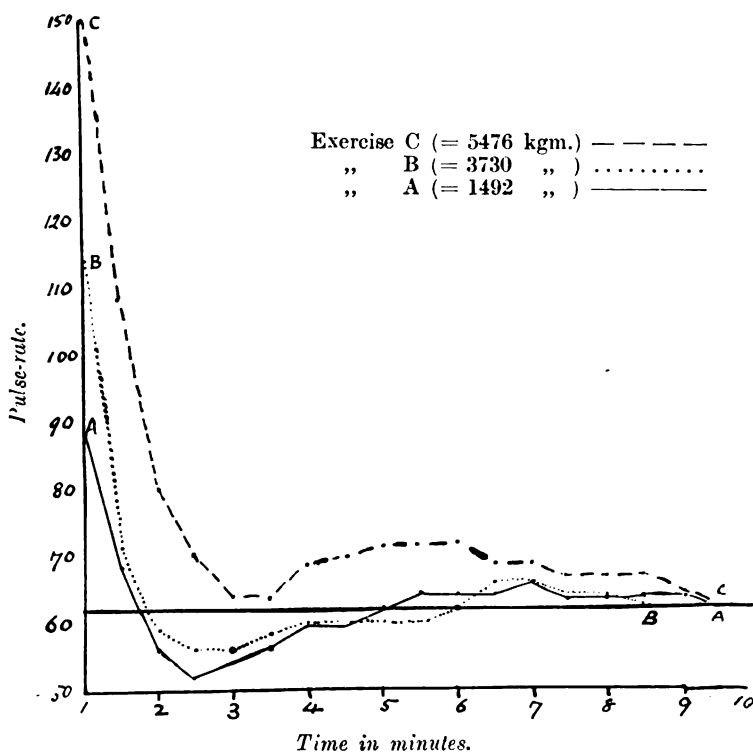


FIG. 1.

Effect of three different exercises on the pulse-rate of the same man. The pulse-rates are plotted vertically, and the time horizontally; thus in exercise A the pulse-rate in the first half minute after exercise was 88, in the second 62, etc. The pulse-rate taken at rest before exercise A was 62, before exercise B 66, and before exercise C 64. For convenience of comparison the three curves are plotted from the same base line (62), and corresponding deductions are made from the pulse-rates after exercises B and C. For example, in exercise C, where the pulse-rate taken at rest was 2 beats faster than before exercise A, 2 beats are subtracted from the rates actually recorded after exercise; thus the count in the first half minute after exercise C was 152; it is marked in the figure as 150 (152-2).

In exercises "B" and "C" the pulse curve has the same shape; in exercise "B" the fall below the original rate is smaller than in exercise "A"; in exercise "C" the pulse-rate continues to fall until the third minute, but the fall is not sufficient to carry the pulse below its original rate, indeed it just fails to

reach this rate by two beats, and does not do so until the ninth minute.*

This difficulty in determining the exact end-point must naturally arise, not only because it is very easy in estimating the pulse-rate by continuous half-minute counts to include a

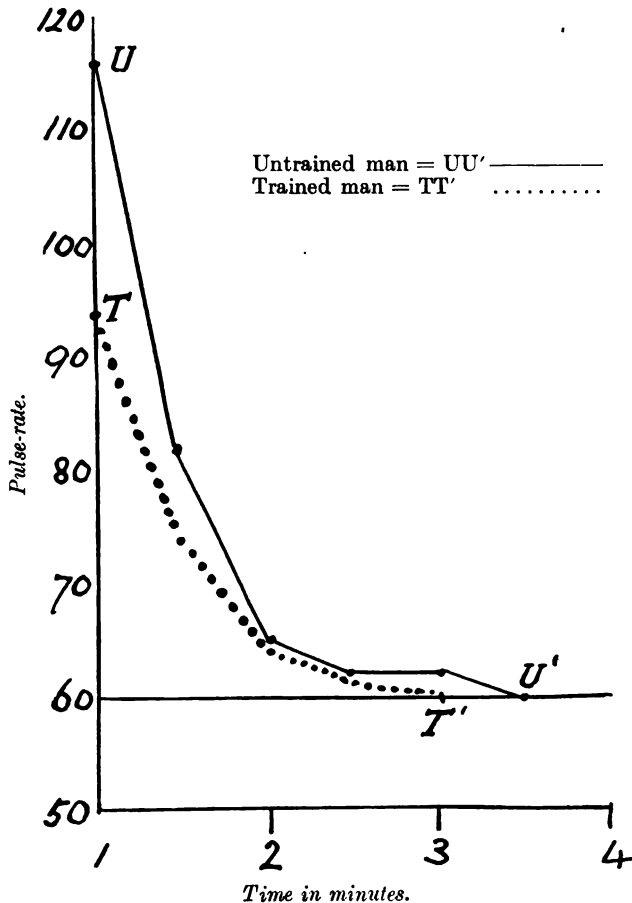


FIG. 2.

Effect of the same exercise on a trained man (T.) and an untrained man (U.). Both curves have been adapted to the same base line, as described under Fig. 1.

beat in the wrong half-minute, but also owing to the fact that the rate of the pulse at rest is not an absolute constant, any more than the rate of respiration, temperature, or other physiological condition.

(2) Fig. 2 shows the effect of the same exercise on the pulse-

* Some unpublished investigations in relation to the fall of the pulse-rate after exercise below the rate at rest were done by one of us (G. H. H.) in collaboration with Miss D. Dufton and Mr. J. Barcroft.

rates of two men, "T" and "U," the former "trained" the latter untrained. The pulse-rate of "T" rises 34 beats, that of "U" 54 beats; the pulse-rate of "U" returns only half a minute later than that of "T." An examination of the curves shows that the difference in the reaction of the pulse lies quite as much in the amount of the immediate increase in rate as in the time of return. Three factors have to be considered and are shown by the curves, the relationship between the increase, the rapidity of the fall, and the time taken to reach the original rate. For convenience in work and the comparison of cases, it is not necessary to wait, it may be for half an hour, for the return of the pulse to its original rate; a satisfactory indication can be obtained by taking the ratio between the average pulse-rate during the two minutes immediately following exercise and the pulse-rate at rest. In this way a ratio, which we may call the "Pulse Ratio," is obtained by dividing the total number of beats during the first two minutes immediately after the exercise by the pulse-rate taken at rest before the exercise. Take, for example, a man whose pulse-rate before exercise is 60; during the first minute after exercise his heart beats 100, and during the second minute 80 times, or $100 + 80 = 180$ in the two minutes; the Pulse Ratio is $180 \div 60 = 3$.

Investigations have been made on the effect of different exercises on the Pulse Ratio. In all cases the exercises lasted five minutes, in order to avoid the complication of a variable time factor. The exercises consisted of walking along the level or up and down stairs a varying number of times, and the relative amounts of work done in each exercise were compared by measuring the increase in respiratory exchange involved in each. As already mentioned, walking or stair-climbing was chosen in preference to any other kind of muscular work such as lifting dumbbells or bicycling on a bicycle ergometer for the following reasons: (1) It is a form of exercise to which every one is accustomed; the experienced cyclist, who is trained to use his muscles at their maximum efficiency works much more economically than the novice, for the latter brings into play groups of muscles whose action is unnecessary. (2) Although it is true that a heavy man in walking upstairs does an amount of work actually greater than a light man, what we really want to compare, especially in pathological cases, is the capacity for moving the body from place to place; in other words we want to know the relative efficiency of men as walking machines. Individuals are physiological units and must be compared as such. The hardest exercise used as a test consisted of running up and down a flight of seven stairs fifty times; by reducing

the number of flights or by combination of stair-climbing and walking along the level any fraction of this exercise could be given. The work done in the hardest exercise by a man weighing 70 kilos was 5810 kilogrammetres, and to accomplish it in five minutes he had to run almost at his top speed; at the end of it

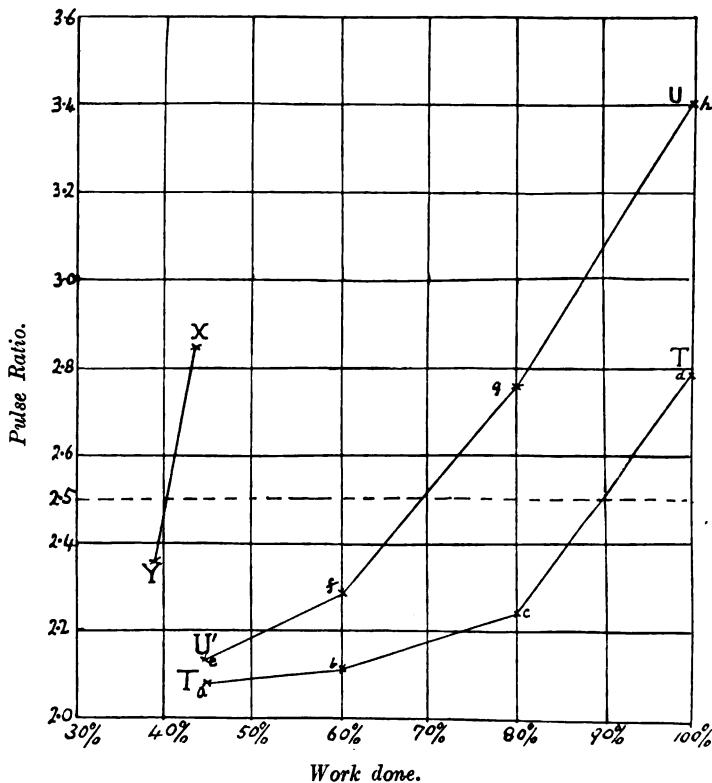


FIG. 3.

The horizontal line shows the amount of work done in percentages of the hardest exercise (100 per cent.). The Pulse Ratios are marked along the vertical line. The points *a*, *b*, *c*, *d*, show the ratios for a trained man (T-T'), *e*, *f*, *g*, *h*, the ratios for an untrained man (U-U') doing 45, 60, 80, and 100 per cent. X-Y show the ratios for a patient with heart disease, 2.37 for 39 per cent. and 2.84 for 44 per cent. The relative efficiencies for the trained man and patient with heart disease are shown where their curves cross the 2.5 ratio, and are as 90 : 40.5 or as 100 : 45.

even the trained man was appreciably short of breath, and the untrained extremely dyspnoeic.

Fig. 3 shows the effect of different exercises on the Pulse Ratios of a trained man, "T-T'," an untrained man "U-U'," and a patient with heart disease, "X-Y." The following points are shown :—

(1) The ratio in each subject is higher the harder the exercise, *i. e.* as the amount of work increases, the rise in pulse-rate immediately after exercise is greater, and the time taken for the pulse to return to its original rate is longer. For example, in the trained man a ratio of 2.07 (marked in the figure at "a") is given by an exercise of 45 per cent.; a ratio of 2.11 (marked at "b") is given by an exercise of 60 per cent.; a ratio of 2.24 (marked at "c") is given by an exercise of 80 per cent.; a ratio of 2.79 (marked at "d") is given by an exercise of 100 per cent. If a line is drawn joining these points, a, b, c, and d, a curve is obtained from which we can read off the ratio given by any exercise between 45 and 100 per cent.; for example, a ratio of 2.5 is given by an exercise of 90 per cent.

(2) If the exercise is kept the same, the ratio in the trained man is lower than in the untrained, and is lower in the untrained than in the man suffering from heart disease, *i. e.* in the trained man the rise of pulse is less and the time of return to the original rate shorter than in the untrained. For example, an exercise of 100 per cent. produces a ratio of 2.79 in the trained man, and a ratio of 3.40 in the untrained.

(3) A harder exercise must be given to the trained man than to the untrained, in order to obtain any given ratio, *i. e.* any given effect on the pulse. A consideration of the third point enables us to compare the efficiency of the untrained man with the trained in the following manner: the trained man doing the hardest exercise has a ratio of 2.79; if we examine the ratios of the untrained man we see that he has a ratio of 2.76 and 3.4 respectively after doing 80 and 100 per cent. of this exercise; if we join these two points on the figure, we find that 80.5 per cent. of the hardest exercise produces a ratio of 2.79. In other words an exercise of 80.5 per cent. produces the same effect on his pulse-rate as an exercise of 100 per cent. in the trained; his efficiency is thus 80.5 per cent. of the trained. In this way it is possible to compare the efficiency of different men in terms of work.

In practice it is found convenient in testing different people to aim at giving an exercise that will produce a ratio of 2.5; we find that with a ratio below 2.3 so little effect is produced by the exercise that the figures are not reliable, and that in some pathological cases an exercise harder than is desirable is necessary in order to obtain a ratio of over 2.7.

The method is as follows: The subject sits on a chair for ten to fifteen minutes, and his pulse is then counted from minute to minute until the rate is found to be constant. He is then told to walk up and down stairs for five minutes sufficiently fast to

make himself slightly out of breath; (in pathological cases it may be desirable to start with a preliminary walk along the level); very slight dyspnœa is generally associated with a ratio a little above or below 2·5. If the ratio is below 2·5, a rather harder exercise is given, if it is above 2·5 an easier one. In this way ratios are obtained for two different exercises, one above 2·5 and one below 2·5; these two ratios are marked on the figure opposite the exercises that produced them. For example, in the case of XY a ratio of 2·35 was produced by 39 per cent. exercise, and a ratio of 2·84 by 44 per cent. exercise; these points are marked in the diagram at X and Y. These points are now joined by a line, and the point at which this line crosses the ratio 2·5 indicates the amount of exercise required to produce this ratio in the man being investigated. In the case of XY the amount of exercise is 40·5 per cent. The trained man has a ratio of 2·5 when doing 90 per cent. exercise, and the subject's efficiency can now be compared with that of the trained man. In the case of XY the efficiency is $\frac{40\cdot5}{90} = 45$ per cent. of the trained man.

We found that the lowest ratios on all the exercises were given by a man who was training strictly for boxing and football; we therefore took him as affording a standard of the highest efficiency, and reckoning him as 100 per cent. efficient we compared the efficiency of every one else with his. Table II shows the efficiency of the following groups of people.

1. Men training strictly for athletics of various kinds.
2. Men not in training, but playing games once or twice a week.
3. Men leading a sedentary life.
4. Women playing games regularly and doing gymnastic training every day. Most of these women were not in such strict training as the men in group 1, but were taking more regular exercise than the men in group 2.
5. Women playing an occasional game of tennis, but otherwise not taking any hard exercise. Most of these women were taking less exercise than the men in group 2, but more than those in group 3.
6. Patients with phthisis. All these were cases of early phthisis, and in all except one the diagnosis was only established after repeated examinations or prolonged observation. The only case in which the unequivocal signs were found on the first examination of the chest was the patient with the lowest efficiency (41 per cent.). The patient with the efficiency of 56 per cent. was tested after he had had nine months' treatment,

and he was then free from all signs and symptoms of any active disease. More information is required on the efficiency in cases of early phthisis, but the evidence of these cases strongly suggests that an efficiency of over 60 per cent. excludes the presence of active pulmonary tuberculosis.

7. Patients suffering from organic heart disease. Excluding the two patients with congenital heart disease, these fall into two groups :—

- (a) Those with auricular fibrillation or valvular disease with enlargement of the heart.
- (b) Those with mitral stenosis without enlargement. The two patients in this group could walk along the level without any dyspnoea, but became short of breath after climbing a long flight of stairs.

The patients in group (a) had much lower efficiencies than those in group (b). This corresponds with their capacity as judged on clinical grounds.

8. Patients suffering from "effort syndrome." None of these were severe cases; the symptoms of the patient with an efficiency of 69 per cent. were very slight.

TABLE II.

Subjects (ages ranged from 18 to 35 years*).	Number of cases.	Average.	Efficiency Range.
1. Well-trained men	4	93% ₀	84-100
2. Semi-trained men	11	76.7% ₀	65-90
3. Men leading a sedentary life	8	64.1% ₀	54-73
4. Trained women	27	83.3% ₀	57 †-107
5. Untrained women	10	72.5% ₀	59-86
6. Patients suffering from phthisis	6	48.2% ₀	41-56
7. Patients suffering from organic heart disease—			
(a) Auricular fibrillation	3	31% ₀	29-33
Mitral and aortic disease	3	34% ₀	25-44
Mitral stenosis with cardiac enlargement	1	37% ₀	—
(b) Mitral stenosis without cardiac enlargement	2	56% ₀	54-58
(c) Congenital heart disease	2	28.5% ₀	24-33
8. Patients suffering from "effort syndrome"	4	58.2% ₀	53-69
9. Patients suffering from chronic lung disease—			
(a) Emphysema without bronchitis	1	62% ₀	—
(b) Emphysema with bronchitis	3	42.3% ₀	36-51
(c) Fibrosis of lung	3	50% ₀	46-55

* With the exception of one patient in group 7 and three in group 9.

† The next in order in this group was 67.

9. Cases of chronic lung disease (not tuberculous). As in the case of group 7 the efficiencies correspond with the severity of the clinical condition with the exception of one case of emphysema and moderately severe chronic bronchitis, where the efficiency (51 per cent.) is a good deal higher than would have been expected. An increase in efficiency is associated with an improvement in a patient's condition. This may be illustrated by the cases of two patients, one with mitral stenosis and the other suffering from "effort syndrome." As the result of treatment with graduated exercises the dyspnoea on exertion decreased considerably. In the former case the efficiency rose from 54 to 64 per cent.; in the latter case it rose from 52 to 69 per cent. By using this method we are thus able to check the effect of treatment.

Conclusions

(1) Tests for physical efficiency are relative to the work done, for this reason the form of exercise should not be specialised but one to which all subjects are accustomed, such as walking or going up stairs.

(2) An exact determination of efficiency can be obtained by a determination of the increase in the metabolism produced by the work, but this method involves too much time, apparatus, and experience to be of general clinical application.

(3) The reaction of the pulse to exercise gives a good indication of the fitness of the subject, for blood flow, pulmonary ventilation and the absorption of oxygen, and the discharge of carbon dioxide vary together.

(4) The method previously employed, namely, a determination of the time taken for the pulse to return after exercise to its original value, has certain objections, which are overcome by the following modification (5).

(5) The ratio between the average pulse-rate for the two minutes immediately following the given exercise and the pulse-rate at rest, "the Pulse Ratio," is a better indication of the reaction of the pulse to exercise.

(6) The Pulse Ratio in relation to given standardised exercises enables physical efficiency to be expressed numerically; that is, in terms of capacity for work (see Table, p. 426.).

(7) The Pulse Ratio supplies a reliable and easily applied method for estimating the effect of treatment and will probably be found of great value in the diagnosis of early phthisis and the estimation of the degree of physical disability.

In a further paper we propose to discuss methods of testing physical efficiency which are based upon other physiological reactions, such as respiration, blood-pressure, etc.

We wish to express our thanks to Miss H. W. Bainbridge, Miss E. L. M. Surie, and Messrs. D. O. Richards, T. A. Shaw, N. R. Spurrell, C. H. C. Toussaint and M. B. P. Killard-Leavey for their help in the observations.

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A CASE OF BILATERAL EIGHTH-NERVE TUMOURS ASSOCIATED WITH MULTIPLE NEUROFIBROMATA AND MULTIPLE EN- DOTHELIOMATA OF THE MENINGES

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THE following case is that of R. C. M., male, age 27, who was admitted to Guy's Hospital under Dr. Hurst on October 23, 1920, for blindness, deafness, and inability to walk.

The *history*, which was obtained from the patient's wife, was that on his discharge from the Army in June 1917, he was somewhat deaf, and complained of noises "like a tram-car" in both ears. He also walked unsteadily, "like a drunken man." He suffered from severe headaches, especially in the early morning, and from dimness of vision in poor lights. The deafness progressed steadily, and by December 1917, was absolute.

In March 1918, he was admitted into a military hospital, where he was found to have organic nerve deafness with absent vestibular reactions, and it was also noted that he had absent ankle-jerks. The Wassermann reaction in the blood and cerebrospinal fluid was negative, but the diagnosis of tabes dorsalis was made as being the most probable explanation of this unusual combination of neurological signs. He subsequently learned lip-reading and was able to teach in a school for the deaf until July 1919, when his vision became much worse. In April 1920, he began to complain of pain in the bottom of the back, and a few months later his wife noticed that in addition to the unsteadiness of his gait, long present, he showed a tendency to drag his feet when walking. The headaches became more severe, and were accompanied by vomiting. In September and October 1920, he was a patient in an infirmary where the medical officer who looked after him noted: "His speech was, I thought, affected, being strongly suggestive of disseminated sclerosis; but his mother, with whom I have since had a talk, tells me his speech has always been slow and deliberate, and is not, in her opinion, altered." A later note adds: "His

complete deafness makes investigation of his mental condition difficult; but, so far as I have been able to judge, it is little or not at all affected. In fact I have been struck with the intelligence with which he grasps a question one wishes to ask, or attempts to carry out a movement one wishes him to perform."

On admission to Guy's Hospital he complained of severe suboccipital headache, loss of sensation over the right side of the face and over the left leg, and pain in the back.

Examination was difficult, as the patient was almost completely blind and deaf, and greatly distressed by his headache. He could, however, be made to hear words shouted into his left ear, and by means of this and tactual sign language it was found that his mental condition was normal. He was able to give clear expression to his wishes, but his speech was halting and explosive, resembling that met with in disseminated sclerosis or cerebellar disease.*

He could distinguish between light and darkness with the right eye, but was completely blind in the left. The optic discs showed a high degree of papillœdema with secondary atrophy.

The right pupil reacted sluggishly to light: the left was inactive. Detailed examination proved tedious owing to difficulty in getting the patient to co-operate on account of his blindness and deafness. The following additional points, however, were established in the examination of the cranial nerves: left-sided ptosis and weakness of all muscles innervated by the left third nerve; absence of both corneal reflexes; weakness of the right face, especially of the lower half; protrusion of the tongue to the right.

There appeared to be some loss of sense of position in the left hand, and general loss of cutaneous sensibility of the left leg. All tendon-jerks in upper and lower limbs were absent, nor could the epigastric or the abdominal reflexes be elicited. The plantar responses were indefinitely flexor on the right; not obtained on the left. An attempt at flexion of the neck upon the trunk revealed considerable stiffness, and gave rise to complaint of pain. Kernig's sign was also present, and its elicitation caused severe pain in the lumbosacral region radiating down the backs of the thighs.

The Wassermann reaction was negative in the blood and cerebrospinal fluid; the latter contained 0 cells per c.mm., protein 0.04 per cent.†

* I made this note before seeing those quoted above from the Infirmary records.

† Lumbar puncture was performed by the house physician before the diagnosis of a tumour in the posterior fossa had been considered.

A provisional diagnosis of acoustic-nerve tumour, probably bilateral, was made, and operation performed by Mr. Bromley on October 30. The patient's condition at that time was extremely grave: during the five days preceding operation the temperature had been subnormal, the pulse-rate had risen from 80 to 110, and respiration was becoming steadily slower.

Suboccipital exploration revealed a tense dura, and when this was opened and the cerebellum exposed there occurred almost at once a gush of cerebrospinal fluid, which was followed by failure of respiration and death.

Post-mortem Appearances.—Apart from the changes in the skeleton and central nervous system, the only point of note was a moderate degree of mitral stenosis. (There is a doubtful history of his having had rheumatic fever when a boy.)

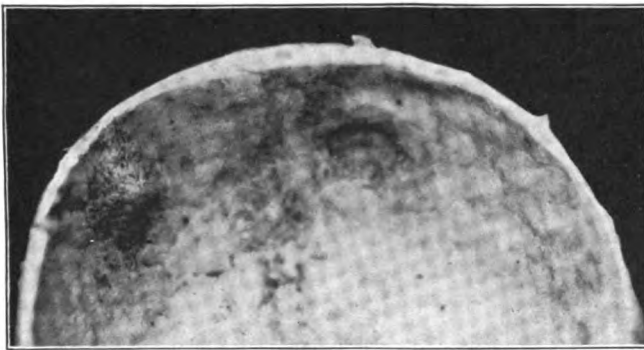


FIG. 1.—Inner surface of posterior part of calvarium, showing exostosis of left parietal bone and circular erosion of right.

The Skeleton.—Skull: 5 cm. to the left of the lambda there is a bony mass projecting from the internal surface of the parietal bone. This is cone-shaped, with maximum height of 1 cm. and maximum diameter 2.2 cm.; 1.5 cm. above and to the right of the lambda on the internal surface of the right parietal bone there is a circular depression 1.5 cm. in diameter: this is roughly saucer-shaped, and in its centre the base is formed by a thin layer of periosteum only (Fig. 1). The internal auditory meatus on both sides is enlarged, especially on the right, and on this side a small portion of the acoustic-nerve tumour to be described broke off and remained in the meatus.

Other bones: No deformity of the thorax or vertebræ was noted. Both tibiæ showed sabre-like bowing.

Meninges.—Over the left parietal lobe there is a deep depression corresponding to the bony projection in the skull, and at this point bone and dura were inseparable without the aid of a knife. Over the postero-superior surface of the right parietal lobe there is a small calcareous button growing from

the outer surface of the dura, corresponding to the cavity of the skull at this point. The cerebral surface of the dura at this spot presents a punched-out hole 5 mm. in circumference, through which the tumour is adherent to brain substance; 1 cm. distant from this there is a small dome-shaped fibrous nodule in the substance of the dura. Overlying the foot of the left precentral gyrus there is another tumour growing from the internal surface of the dura. This is an irregular nodular mass, 3.5 by 2.5 cm. in its widest lateral dimensions, and 1 cm. in depth (Fig. 2). There are many small fibrous plaques scattered about the internal surface of the dura, which look as if they might be starting-points of other growths.

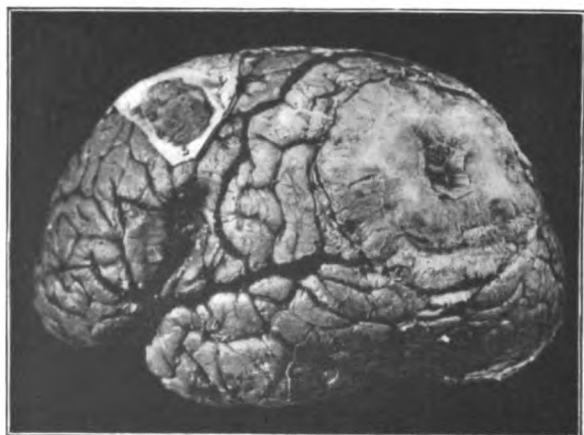


FIG. 2.—Lateral view of left hemisphere. The fissures of Sylvius and Rolando are rendered conspicuous by the insertion of strands of dark wool. In the precentral region a portion of the dura has been left intact and hinged back to show the tumour; below is the depression caused by it in the surface of the brain. The tumour of the parietal lobe has been replaced *in situ* after enucleation.

Brain.—Occupying the posterior part of the left parietal lobe, as shown in the photograph (Fig. 2), is a large solid tumour the external surface of which is roughly circular and flush with the surface of the brain. In its centre is a depression corresponding to the bony projection of the skull referred to above, and at this point the dura is inseparable from the tumour. The diameter of the tumour is 6 cm., and it is situated in the area normally occupied by the supramarginal and angular gyri. It was readily enucleated from the brain substance, and then proved to be roughly hemispherical, as seen in the photograph (Fig. 3), its greatest depth being 4 cm. The contours of the neighbouring gyri are so much distorted as the result of pressure that it is not possible to determine their outlines with accuracy.

At the foot of the left precentral gyrus, and extending forward into the inferior frontal gyrus, is a depression measuring 3 by 2 cm., and 2 cm. in depth, corresponding to the tumour

growing from the superjacent dura (Fig. 2). The anterior ascending ramus of the Sylvian fissure lies in the anterior wall of this depression, which therefore includes the intermediate and posterior parts of the inferior frontal gyrus.

At the base of the brain the cerebello-pontine angle on either side is occupied by a nodular tumour the size of a small walnut (Fig. 4). On the right side the fibres of the seventh nerve are visible spread out over the inferior surface of the tumour. On the left side also some fibres apparently of the seventh nerve are seen on the surface of the growth. When the tumours are lifted aside, the lateral aspect of the pons on each side is seen to be deeply indented, and the trigeminal nerves are flattened by pressure.

Spinal Meninges and Nerve-roots.—Growing upon the inner surface of the dura are many hard plaques of a nature similar to those seen on the cerebral dura, but of a smaller size. There are also one or two similar nodules definitely arising in the arachnoid. The largest of these latter, the size of a split pea,



FIG. 4.—Base of brain showing a tumour of the eighth nerve in the cerebello-pontine angle of either side.



FIG. 3.—Lateral view of parietal tumour shown in Fig. 2, after enucleation (superficial aspect to the left).

appears to be almost free, being attached by very slender connections to a slip of the ligamentum denticulatum. Upon almost all the nerve-roots there are small fusiform swellings of the type usually known as neurofibromata. There is one nodular swelling much larger than the others (2 cm. in diameter) growing from one of the upper sacral roots on the right side and compressing the conus medullaris and the neighbouring nerve-roots (Fig. 5).

The outline of the left lateral surface of the cord is interrupted at the eleventh dorsal level by the projection of a round nodule which appears to lie beneath the arachnoid (Fig. 5).

The Peripheral Nerves.—During life no subcutaneous tumours were observed of the type met with in von Recklinghausen's disease, but at the post-mortem Dr. Ryle discovered a small

nodule apparently growing from one of the subcutaneous nerves of the right leg. This was taken for histological examination, but was unfortunately lost.

Microscopic Examination.—Sections were cut of the tumour growing from the left eighth nerve, of a small nodule from one of the posterior nerve-roots, of the nodule described as arising from the arachnoid of the ligamentum denticulatum, and of the larger tumour situated upon the cauda equina. Sections were also cut from the edge of the nodular growth of the dura in the left precentral area. Transverse sections were made of the cord in the mid-dorsal region, and at the point where the subarachnoid nodule referred to above lay upon its surface.

The eighth-nerve tumour shows the microscopic appearances characteristic of these growths. The area examined consisted mainly of a loose reticular formation, the cells having small round nuclei and irregular stellate cytoplasm. There are



FIG. 5.—Lower part of spinal cord with meninges and nerve-roots. For description see text.

also strands of densely-packed cells with oval nuclei and slender fusiform cytoplasm which show a tendency to arrangement in whorls. These cells do not take up the fuchsin of Van Gieson's stain, but remain a brownish-yellow, in contrast with the bright pink of the blood-vessels and capsule of the tumour.

Many of the vessels

show great thickening and hyaline degeneration.

The sections of the tumour of the cauda equina show very much the same structure, with the addition, however, of many scattered areas in which the fusiform cells show the palisade arrangement of nuclei illustrated in Cushing's monograph.¹

Longitudinal sections through the small posterior-root tumour show this to be composed of fusiform cells of similar appearances and staining reactions to those described above.

The sections through the tumour lying upon the surface of the cord prove this to be another growth of similar type, developing apparently from posterior-root fibres, and at one point invading the substance of the cord along the line of the posterior horn of grey matter. Here the strands of advancing fusiform cells are surrounded by a marked increase in glia-cell formation. The appearances are almost identical with those figured by Passoe and Nazum² and by Bruce and Dawson³ in similar cases.

The structure of the dural tumours is that of the so-called endotheliomata. They are composed of oval or spindle-shaped cells with a definite tendency to whorl formation and calcifica-

tion, and the resultant appearance of psammoma bodies. The cells lie in closely-packed masses in a frame-work of connective tissue and blood-vessels which takes on the characteristic pink colour with Van Gieson's stain. In the section from the edge of the smaller tumour, finger-shaped processes of these cells are clearly seen invading the under surface of the dura in a manner which reminds one of a basal-celled carcinoma.

It proved impossible to cut the arachnoid nodule without preliminary decalcification. It is almost entirely composed of psammoma bodies, in the outer walls of which occasional cells are to be seen of similar nature to those seen in the dural tumours.

A section through the cord at the mid-dorsal level stained by the Kulschitzky-Pal method shows some degeneration of the fibres of the posterior columns, presumably secondary to the posterior-root destruction at lower levels.

Symptomatology.—The main points in the symptomatology of eighth-nerve tumours are well known, especially since the publication of Cushing's monograph.¹ In his series one case is recorded in which the presence of bilateral deafness and multiple cranial-nerve palsies led to a diagnosis of bilateral acoustic neuroma, whereas there was found after death a single large tumour on the left side, with great distortion of the pons and other structures at the base. It is of some interest to note that in this case of Cushing's there was paralysis of both third nerves, a condition for which he finds it difficult to give a satisfactory explanation. In the case recorded above, the paralysis of the left third nerve gave rise to some difficulty in making the diagnosis, but is probably to be explained as being due to the degree and duration of increased intracranial tension; in Cushing's case also the history covered more than two years, and total blindness had resulted from secondary optic atrophy. The third-nerve palsy therefore is to be regarded as one of those late "false localising signs" which, as Collier⁴ has shown, often occur in the presence of greatly increased intracranial tension, adding much to the difficulties of diagnosis.

Against this, standing out in the background of the picture, is the early history of tinnitus and deafness—facts which were only elicited by close questioning of the patient's wife, but were of the highest value in arriving at the diagnosis. Cushing¹ has emphasised the constancy of these subjective troubles of hearing and their invariable occurrence at an *early stage* of growth in cases of eighth-nerve tumours.

It is interesting to note that in this case some degree of hearing was preserved in the left ear long after vestibular reactions had been lost. This is in accord with the view of

Henschen,⁵ that these tumours arise primarily from the vestibular rather than the cochlear root. In point of fact in this case, as in one reported by Biggs⁶ and another by Bassoe,² the larger tumour was on the side on which hearing had been retained. It is therefore of interest to note that the right-sided tumour in this case was at its apex so firmly embedded in the internal auditory meatus that this fragment of it was broken off in removal, whereas on the left side the tumour came away from the bone quite easily. It would seem possible that the degree of deafness depends upon the tightness with which the cochlear root is wedged against the walls of the bony canal.

Passing to the symptoms of pressure upon surrounding nerves, those referable to the trigeminal are in accord with the general rule that pressure exercised upon the sensory root (*i. e.* proximal to the Gasserian ganglion) causes anæsthesia—not pain. On both sides the trigeminal root was flattened out between the tumour and the pons. The sixth nerves had, as usual in tumours of this type, escaped direct pressure. Unfortunately no note was made of the functional efficiency of this pair, but my impression is that the left eye was entirely paralysed for outward as well as inward movement. The sixth nerve, perhaps on account of its long course, is frequently paralysed when intracranial tension is extreme.

There is some doubt whether the facial weakness on the right side should be attributed to direct pressure upon the nerve or to the effects of the dural tumour pressing upon the left precentral cortex. Probably the latter is the correct interpretation, since the tongue also was weak on the right side without any obvious wasting. It is at any rate remarkable that such a degree of distortion of both seventh nerves should be accompanied by no more definite signs of facial palsy.

In relation to the large tumour pressing upon the cauda equina, the most interesting point is the loss of ankle-jerks, which preceded by a long time the appearance of pain severe enough to be a prominent feature in the story. The absence of sphincter disturbances also is of interest.

On the other hand, the history was incomplete, and both root pains and loss of sphincter control may have existed at some time and have been accepted as signs of tabes.

In the later stages of the illness the absence of all tendon-jerks was presumably due to the break in the reflex arcs occasioned by the presence of the multiple tumours upon the posterior nerve-roots.

The two endotheliomata shown in Fig. 2 are, on account

of their situations, of some interest in relation to problems of the localisation of speech centres in the brain. The smaller tumour had produced a considerable indentation of the cerebral surface in precisely that area in which Broca and his many followers have found that a superficial lesion will give rise to paresis of verbal utterance. The larger tumour had burrowed deeply into those parts of the parietal and temporal lobes which are considered to be of functional importance in the reception of speech and in the elaboration of intellectual processes in terms of speech.

The problems of aphasia have been recently reviewed in this country by Head ⁷ and others ⁸; and in France Marie and Foix ⁹ have reported in detail the results of studies of aphasia following gunshot wounds of the cortex in correlation with anatomical localisation of the lesions. In these papers there appears to be nothing to contradict the general statement that, in the case of a right-handed person, a lesion in either the posterior part of the inferior frontal convolution or in the supramarginal and angular gyri in the left hemisphere will give rise to disturbance in the former situation of outgoing speech and in the latter site of incoming speech.

It has been ascertained from the relatives of this patient that he was always right-handed in everything he did. On the other hand, it is to be regretted that he was not more carefully examined from the point of view of speech disturbance. He certainly had some difficulty in vocal utterance, the words being widely spaced and blurted out with undue effect. This was set down at the time of examination as being due to interference with the co-ordinating functions of the cerebellum. It may, however, have been a minimal sign of motor aphasia. In any case it was insufficient to have attracted the attention of his wife or mother.

On the receptive side one may say with certainty that there was no gross disturbance of speech recognition. Provided one shouted loud enough into his left ear, he was quick to obey any command or answer any question, however complicated. A further point of interest is furnished by the fact that the sister in charge of his ward was an expert in tactual sign language in which the patient had been trained, and was able to ask him questions in this way. Not only was he able to appreciate the individual letters correctly, but he showed a high degree of facility in guessing the whole of a word from the first few letters, or the whole of a sentence from the first few words, according to the context. It was noticeable that he always used the left hand for the reception of these tactual messages.

Marie and Foix's⁹ observations show that lesions of the supramarginal and angular gyri are generally accompanied by "global" aphasia and apraxia; and Bremer¹⁰ has recently published a case in which the same clinical picture was caused by an endothelioma which in size, shape, and situation closely resembled that seen in the present instance. What, then, is the explanation of the relative absence of speech disturbance in the present case?

It may be that the extracortical tumours of slow growth, such as the endotheliomata, cause relatively little damage to the brain in spite of their great size. Evidence of this kind is furnished by the very complete recovery which patients make when these tumours are removed at operation, showing that what damage there is, is not of a permanent nature. In Bremer's case, referred to above, the patient had almost completely recovered from a very severe degree of aphasia a month after his operation.

An alternative hypothesis that may be tentatively put forward in this case rests upon the theory of "stock-brainedness." Foster Kennedy¹¹ has collected a group of cases showing that in a right-handed person coming of left-handed stock the speech centres may be situated on the right hemisphere instead of the left. Inquiry in the present case has elicited the fact that the patient's paternal grandmother was left-handed, but that all other members of the family in the present and past generations are right-handed. It is thus barely possible that the patient, being a right-handed person, yet had his speech centres located in the right hemisphere.

Pathology.—The association of bilateral eighth-nerve tumours with multiple neurofibromata of the central and peripheral nervous system is well known, and, although it is a rare condition, many cases have now been recorded, of which those reported and illustrated by Bassoe and Nazum² and Hall and Beattie¹² are typical examples. There are, furthermore, several cases on record in which the co-existence of multiple endotheliomata of the meninges has been noted. Cushing,¹ in a brief review of the literature upon this point, concludes that generalised neurofibromatosis, isolated tumours of the eighth nerve, and fibro-endotheliomata of the meninges are in some fashion correlated lesions. He says "it would seem probable that some anomaly of development of the nervous system and its envelopes must be the underlying factor." He assumes that the endotheliomata and the neurofibromata are "obviously of an utterly different pathological character."

On the other hand, Greenfield,¹³ describing the histological

appearances of a tumour of the occipital cortex in a case of this type, concludes that, although in many respects resembling an endothelioma, it is more closely allied to the other tumours (neurofibromata) of the series.

In the present case the microscopic appearances of the two sets of tumours are quite distinct, and lend support to Cushing's view. The cells of the nerve tumours are uniformly more elongated and slender than those of the dural growths. The former show no tendency to the formation of psammoma bodies, in which the latter abound. And whereas in the former there is very little connective tissue (pink staining with Van Gieson's stain) except immediately around the vessels, in the latter there is a distinct fibrous framework.

As to the nature and origin of the nerve tumours, every aspect of this problem has been most fully discussed by Durante¹⁴ and in the detailed histological studies of Bruce and Dawson.³

Cushing¹ and Greenfield,¹³ in recent reviews, both favour the hypothesis that these tumours arise from the cells of the neurilemma or sheath of Schwann, which originally develop from the neural crest. On this assumption, in spite of the superficial resemblance of these growths to young fibrous tissue, there is no justification for the appellation fibroma, and the term neurinoma coined by Verocay¹⁵ would seem to be more suitable.

The microscopic appearances and staining reactions of the cells of this series in no respect differ from those reported by other observers, and the picture of slim fusiform cells invading the cord in the posterior-root-entry zone shows a striking similarity to that of Plate VI, Fig. 53, in Bruce and Dawson's work.³ As they remark, "it seems as if the neurilemma sheath in relation to the posterior roots were continued along the fibres right into the root-entry zone."

Bony Deformities.—The forward bowing of the tibiæ in this case was not assigned any importance in making the diagnosis, but there seems to be little doubt that it should be connected with the presence of multiple neurofibromata. Marie and Couvelaire,¹⁶ in a detailed record of a case of generalised neurofibromatosis, drew special attention to the skeletal changes, which in their case were confined to the thorax. The bones were soft, flexible, and light, so soft that "on a pu modeler à sa guise ce bizarre thorax." They remark upon the likeness of the bone condition to that met with in osteomalacia, and quote other observations by Jeanselme¹⁷ and Hoisnard.¹⁸ One of Jeanselme's¹⁹ cases is said to have shown a *sabre-like*

deformity of the right tibia. Lion and Gasne²⁰ reported a similar case in which, in addition to the thoracic deformity, there was an enlargement of one ulnar bone, in the centre of which an x-ray plate showed an area of decalcification. They also refer to a case described by Raymond in which there was similar deformity of the humerus.

Pearce Gould,²¹ writing in 1918 upon the bony changes occurring in von Recklinghausen's disease, declares that skeletal deformities are among those constantly to be found in addition to neurofibromatosis. He further quotes a statement (without reference) to the effect that they occur in a degree noticeable during life in about 7 per cent. of all cases. In one of the cases which he examined he found that all the bones were soft and cut easily with a knife, and microscopical sections showed the presence of much osteoid tissue with little calcification. He concluded that the histological picture was that of osteomalacia, rather than that of osteitis fibrosa or simple decalcification. The patient from whom the tissues were taken is said to have had an exaggerated knee-jerk and Babinski's sign on the right, but there is no post-mortem report upon the nervous system. I have not been able to find in the literature any instance in which bony changes are described in a case of central neurofibromatosis without subcutaneous tumours, but there seems to be no reason why they should not occur.

My acknowledgements are due to Dr. A. F. Hurst for permission to publish the clinical notes of this case, and to Dr. P. P. Laidlaw for much assistance and advice in the preparation of the photographs.

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STUDIES IN GASTRIC SECRETION

VI. A NOTE ON PYLORIC OBSTRUCTION

By J. A. RYLE, M.D., Assistant Physician to Guy's Hospital.

It will be generally accepted that duodenal ulcers, by reason of their proximity to the pyloric sphincter, produce symptoms and signs, radiographic appearances, and chemical and motor phenomena all more readily and constantly appreciable than is the case with ulcers involving the body of the stomach. In organic pyloric stenosis the clinical and radiographic pictures become even more clearly outlined, and the gastric tube may provide an actual diagnostic test. Having regard for the anatomical definition and physiological importance of the pylorus, some such constancy of response to lesions affecting it might well be anticipated.

In a previous paper of this series I discussed the significance of "the hypersecretory curve," which is so often obtained in cases of duodenal or other juxta-pyloric ulcers, and expressed the opinion that the swiftly climbing curve and sustained plateau were dependent on two main factors: firstly, a reflex exaggeration in the rate of secretion; and secondly, a reflex exaggeration of pyloric tonus, resulting in a temporary, partial, and purely "functional" stenosis.

In the present note are described the results of fractional analysis in undoubted organic stenosis of the pylorus.

The findings are, as might be expected, considerably different in the case of obstructions due to malignant growth and those due to other causes, such as simple ulcer and cicatrisation after trauma by a caustic poison, one case of which is included in the small series under review.

Among twelve cases of pyloric obstruction, all except one of which were confirmed at operation, seven followed simple ulcer, one was due to pre-pyloric scarring following accidental swallowing of a caustic alkali, and four were cases of pyloric neoplasm.

In all the cases the usual precautions were observed, and the patients were forbidden to take any food after 9.30 p.m. on the evening preceding the test.

In cases of pyloric obstruction following simple ulcer a very constant picture is obtained, though slight variations dependent on the degree and duration of the stenosis are encountered. The main features of a positive diagnostic test may be described as follows.

(1) The fasting juice may or may not contain food-residue; when present, the residue has a very turbid appearance and a porridge-like consistency, is usually brownish in colour, and has a peculiar and unmistakable half-sour, half-musty odour. In amount it is variable, and it is often difficult, on account of its consistency, to withdraw the whole through the small tube employed in fractional analysis.

In cases in which the stenosis is less complete, and in which vomiting may perhaps have been entirely absent while the patient was careful with his diet, the ordinary clear juice, such as is found in cases of duodenal ulcer, is obtained; it may be present in abnormally large amounts.

Whether food-residue is present or not, the free and total acidity of the fasting juice give readings above the average normal limits.

(2) Macroscopic inspection of the rack of tubes after standing reveals, instead of a step-like fall in the sedimented gruel content, a sustained level of gruel in the tubes throughout the series, with a clear layer of supernatant fluid in each.

(3) Bile regurgitation is usually absent; it was absent throughout the test in every case in the series, except in one in which there was old partial cicatricial contraction of the first part of the duodenum.

(4) In two cases, in one of which, the traumatic stenosis, eructations of gas having the odour of sulphuretted hydrogen constituted a leading symptom, there was active fermentation in several of the tubes, small bubbles being seen to rise continually to the surface. In no cases other than cases of pyloric obstruction has the writer ever observed active gas-production in specimens withdrawn for fractional analysis.

(5) The secretory curve shows very constant features. Following the initial fall due to dilution by the ingested gruel, there is a slow, gradual ascent to a moderately high point between 50 and 70 for the free acid, which seldom reaches the very high figures obtained in cases of active non-obstructive ulcer.

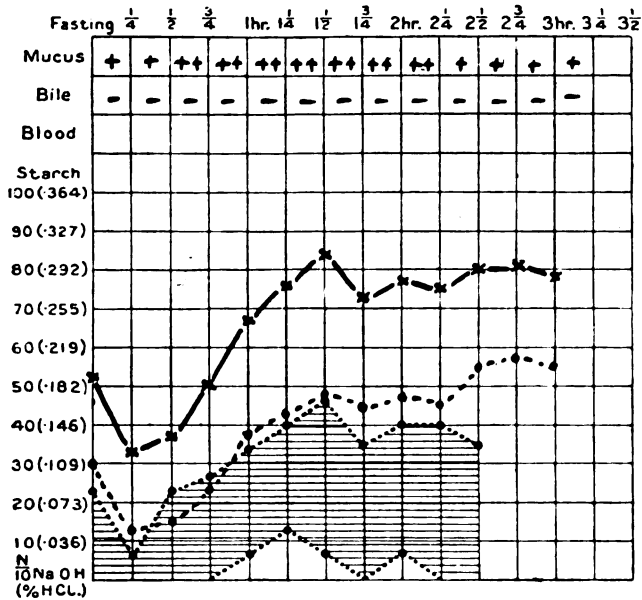
(6) The curves of free and total acidity run closely parallel, but owing to food-retention show a wider interval than is usual in non-obstructive lesions.

(7) The rate of emptying is definitely delayed, usually

beyond three hours; or if the test is concluded at two and a half hours, an abnormally large quantity still containing gruel can be withdrawn at that time.

The explanation of the slowly climbing curve is simply that secretion is taking place into a fixed volume of fluid while neutralisation by duodenal reflux is prevented.

Chart 1, obtained in a case of pyloric stenosis due to ulcer, shows the main features detailed above.



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The shaded area represents the limits for free HCl of 80% of normal people.

represents free HCl.

— represents total acidity.

CHART 1.

Pyloric obstruction following ulcer. First specimen contained no food-residue; thereafter starch present in abundance throughout. Confirmed by x-rays and operation.

An almost identical curve was obtained in four of the remaining seven ulcer cases and in the case of cicatricial contraction following caustic alkali poisoning.

In cases in which there has been a more general destruction of gastric mucosa by a caustic poison a low or absent free acidity might be anticipated, but in this instance a localised fibrotic stricture had resulted.

Similar curves have also been seen in cases not included in the series. In the three cases of the series which did not show identical behaviour the incomplete withdrawal of the food-

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as judged by the presence or absence of food-residue in the first specimen and by the rate of emptying; and thirdly, in that it permits of a reasoned opinion as to the likelihood of the obstruction being malignant or otherwise.

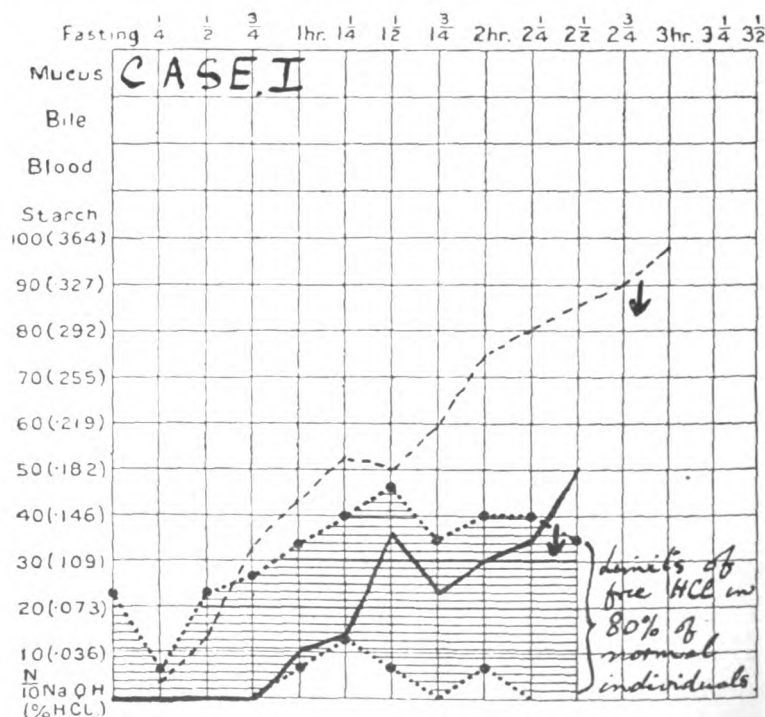
Where an x-ray examination is not available, it provides the most simple and practical aid to the clinical diagnosis of pyloric obstruction, but its advantages over a combination of the older one-hour and a twelve-hour test are admittedly few.

Though useful information relative to gastric secretory and motor efficiency is often forthcoming in other conditions, pyloric stenosis is the only condition in which the method of fractional analysis provides a completely diagnostic curve.

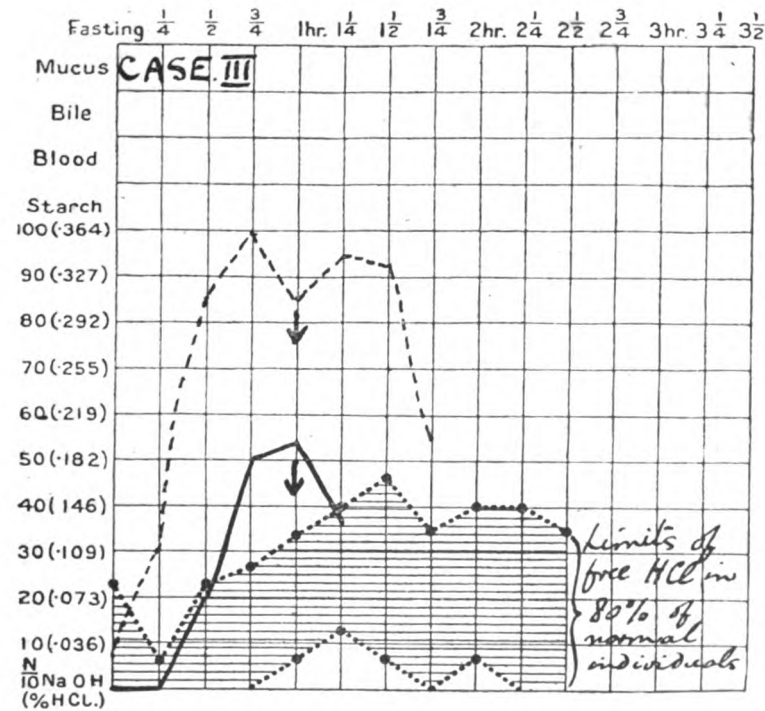
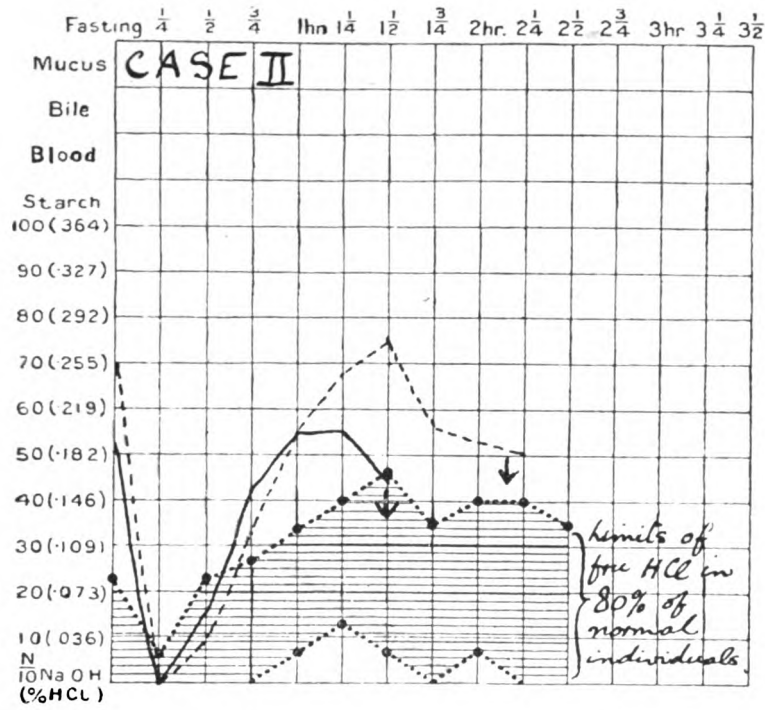
VII. THE EFFECT OF BELLADONNA IN HYPERCHLORHYDRIA

By R. D. ROBERTS, M.B., R.M.O., New Lodge Clinic, Windsor Forest.

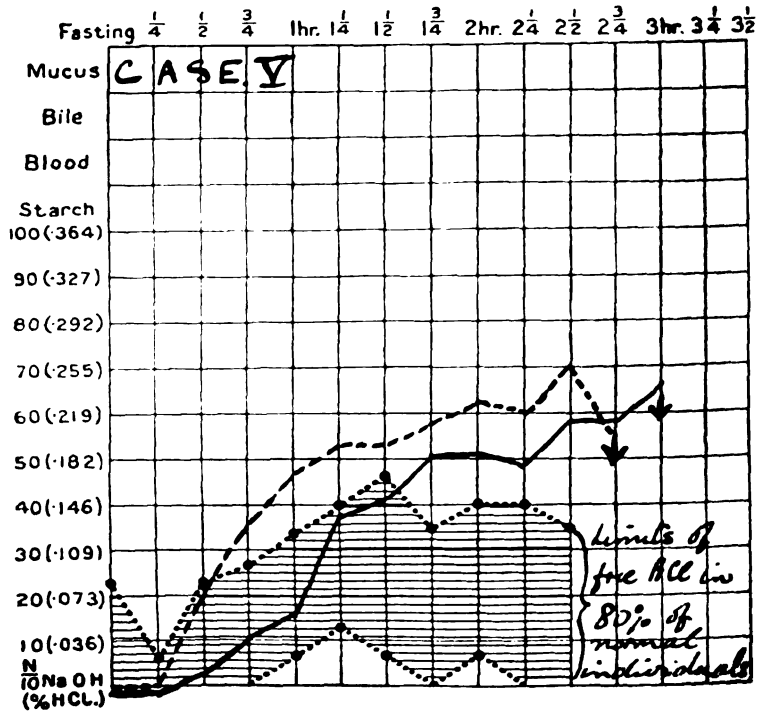
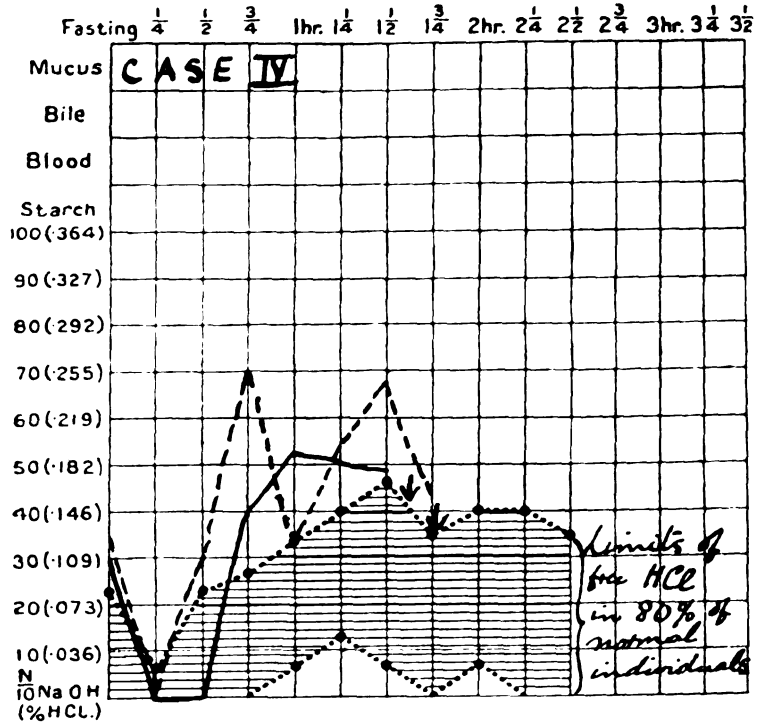
IN the *Guy's Hospital Reports* for January 1921 Dr. Izod Bennett published an article part of which dealt with this



subject. He experimented with normal individuals, giving them test-meals first without—and secondly after—atropine.



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In one series of experiments the atropine was administered in a dose of 1/80 gr. hypodermically before the meals. In a second series the stomach was emptied, 1/80 gr. of atropine sulphate in 60 c.c. of water being introduced for one minute, and then withdrawn before the test-meal was given. He found that in each case atropine produced a prolonged diminution in acidity.

I am indebted to Dr. A. F. Hurst for his kindness in allowing me to publish the following curves of five cases at New Lodge Clinic, which illustrate the effect of tincture of belladonna in patients with hyperchlorhydria, but presenting no evidence of organic disease. They support Bennett's conclusion and are perhaps of special interest in that the atropine was given in the more usual form of tincture of belladonna by mouth before the meals. Moreover, all the patients had hyperchlorhydria, which is the chief condition in which it is desirable that a fall in the secretory activity of the stomach should be obtained. It is noticeable that the effect is most marked in Cases 1 and 3, in which the hyperacidity is highest.

Case 1 was a female, age 28, with hyperchlorhydria and hypersecretion of apparently nervous origin, who suffered from discomfort beginning two or three hours after meals with frequent vomiting. After various forms of treatment had failed to give relief, the administration of belladonna produced great improvement, and with its continued use this improvement has been maintained since leaving New Lodge in May 1921. The other cases did not present any symptoms that could be definitely ascribed to hyperchlorhydria.

The broken line in each chart represents the free HCL normally; the continuous line represents the free HCL in the same subject after the administration of tincture of belladonna by the mouth. The arrow indicates the time of disappearance of starch.

In Case 1 tincture of belladonna, min. xv., was given in water just before the test-meal. In Cases 2, 3, 4, and 5 the same dose was given half an hour before the test-meal.

GASTRIC AND DUODENAL ULCER AS FAMILY DISEASES

By ARTHUR F. HURST, M.D., Physician to Guy's Hospital.

WHEN careful inquiries are made a family history of gastric and duodenal ulcer is frequently obtained from patients suffering from these conditions. It is curious that this fact has very rarely been recognised in the past. It is not mentioned in the large majority of books on diseases of the stomach or on general medicine, whether published in England, America, France or Germany. The following are the only references to the subject I have been able to find. Dreschfeld ¹ in 1897 wrote that in eight of his cases he regarded the evidence of gastric ulcer occurring in various members of the same family as conclusive: in two instances, mother and daughter suffered from it; in one, father and daughter; in two, two sisters, and in one, a brother and sister suffered from unmistakable symptoms of the disease.

In 1907 Huber ² described eleven cases of gastric ulcer, representing 15 per cent. of those he had seen in a certain period, in which a family history of the disease was obtained. Three years later von Czernecki ³ published the history of a family, of which five members had symptoms of gastric ulcer.

In 1914 von Plitek ⁴ recorded the case of a man who was operated upon for a perforated gastric ulcer; a paternal male cousin, aged 43, had a perforated gastric ulcer successfully sutured, whilst the following day his brother, aged 56, died from peritonitis following a gastro-enterostomy performed for a chronic pre-pyloric ulcer.

I have seen several cases in which two or more brothers and sisters have suffered from gastric and from duodenal ulcer, and still more in which brothers and sisters of a patient with a gastric or duodenal ulcer have had symptoms of a similar character, but so much less severe that it seemed doubtful whether actual ulceration was present.

The following are the most remarkable duodenal ulcer families I have met with. In the first the father and two out of nine children were dyspeptic, and four others had typical



symptoms of duodenal ulcer, one dying from a perforation; in the second the mother and all three sons and one grandson had duodenal ulcer.

FAMILY A.

Mother. No indigestion. Now 75 and well.

Father. Died of chronic Bright's disease at 77; always *dyspeptic* and gouty; used to take vast quantities of Tr. Rhei Co. (neat) and said to have "gouty dyspepsia."

Children. 1. Male. *Dyspeptic*; very atypical.

2. Male. Died of perforated *duodenal ulcer* at 35 years. Very long and typical history.

3. Female. Always *dyspeptic*; not typical *duodenal ulcer*; now 45.

4. Male. Typical *duodenal ulcer*; symptoms for years.

5. Male. Occasional attacks typical *duodenal ulcer*; pain in winter.

6. Male. Very fit; 6 ft. in height and proportionately big.

7. Male. Typical *duodenal ulcer*.

8. Male. Athlete of exceptional power; very fit.

9. Female. No symptoms.

FAMILY B.

Father. Suffered from attacks of diarrhoea. Died from sudden heart failure at 74.

Mother. Died at 78. All her life had *duodenal ulcer*—typical hunger pains, for which she took alkali and food between meals.

Children. 1. Male, 55. Several attacks typical *duodenal ulcer* beginning when 45.

2. Male, 52. *Duodenal ulcer* since 40. Confirmed by operation. Gastro-enterostomy when 49, followed by *jejunal ulcer*.

3. Male, 45. *Duodenal ulcer* since 37. Perforated July 1915, and again in July 1916.

Two sisters, 56 and 50, with no gastric symptoms. A third sister died in 1886, aged 17, from supposed perforation of appendix, but no operation.

Grandchild. Male, 27, son of 1. Typical *duodenal ulcer* since 1917, when in France.

A medical man with typical duodenal ulcer symptoms belonged to a family in which so many individuals suffered from a sinking sensation requiring frequent meals for their relief that they familiarly spoke of the "family sinking." His mother required frequent meals during the day, and a younger brother and sister both felt marked sinking about two hours after meals, which was only relieved by food. His father and elder sister and a younger brother were not troubled in this way, but several cousins had the characteristic "family sinking."

It is an interesting fact that I have never myself seen one member of a family in whom the presence of a gastric ulcer was proved and another in whom a duodenal ulcer was certainly present. This suggests that the types of stomach which predispose to the development of gastric and of duodenal ulcers respectively are congenital, and either one or the other may exist in several members of a family.

I am indebted to Dr. J. A. Ryle for the histories of the following families.

FAMILY HA.

Father, died of bronchitis and Mother of cancer of breast.

1. Helen H., died in 1904, aged 38, after operation for *retro-peritoneal abscess and peritonitis*.
2. Ernest H., died in 1919, aged 45, after gastro-jejunostomy for *duodenal ulcer*.
3. William H., now 42, was operated on in 1907 for *duodenal ulcer*.
4. Beatrice H., died in 1910, aged 22, after operation for *perforated gastric ulcer*.
5. Eva H., suffered from *indigestion* and died suddenly when 29.
6. Henry H., aged 22, was operated on for *duodenal ulcer*.

As a perforated duodenal ulcer is very often mistaken for a gastric ulcer, Beatrice H. may really have had the former.

Both Helen H. and Eva H.'s deaths may well have been also due to perforated duodenal ulcer.

FAMILY P.

1. Father, died from "*stomach trouble*."
2. Mother, had *gastric ulcer*.
3. Son, operated on for *duodenal ulcer*.
4. Son, operated on for *gastric ulcer*.
5. Richard P., aged 18, had phenomenal appetite from early childhood. On and off since 11 had symptoms very suggestive of *duodenal ulcer*, now confirmed by Dr. Ryle with x-rays and presence of occult blood in stools.

FAMILY D.

1. Mother, *gastric symptoms* since 16.
2. Son, died when 42 from hæmorrhage from a *gastric* ulcer.
3. Son, aged 30, symptoms of *gastric ulcer* since 16.
4. Son, aged 18, just started symptoms of *gastric ulcer*.

The frequency of a family history in gastric and duodenal ulcer is additional evidence in favour of the view that they are typical

advanced on a number of occasions⁵ that there is a gastric and a duodenal ulcer diathesis, which lead to the development of actual ulcers under certain conditions, which would have no such effect in normal individuals. This diathesis explains the tendency to recurrence of ulceration, and requires consideration when the prophylaxis, prognosis and treatment of gastric and duodenal ulcer are discussed.

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THE RELATIVE MERITS OF CHOLECYSTECTOMY AND CHOLECYSTOSTOMY

By R. P. ROWLANDS, M.S., Surgeon to Guy's Hospital.

THE more we study the natural history of the human gall-bladder in health and especially in disease, the more we come to regard it as a useless and troublesome vestigial organ like the appendix vermiformis. Various animals, such as the horse and the rat, get on very well without it, and its removal in man is not followed by any serious physiological or pathological changes. It is true that the large bile ducts dilate to a slight extent after cholecystectomy, but no serious harm results.¹ The loss of the gall-bladder as a storehouse for bile and a secretor of mucus is apparently immaterial, for a large number of people have survived cholecystectomy for many years without suffering any inconvenience, provided always that the bile ducts are patent to allow the bile to flow without let or hindrance into the duodenum. It is generally admitted that the gall-bladder is the factory of nearly all gall-stones, which may cause infinite trouble and danger in the gall-bladder, bile ducts, and intestines. The removal, therefore, of the source of this trouble is very attractive to the surgeon and advantageous to the patient. If an irremovable obstruction of the common bile duct develops later, the loss of the gall-bladder is certainly a disadvantage, for cholecystenterostomy cannot be performed to relieve jaundice and choledochenterostomy is a much more difficult operation. Carcinoma of the head of the pancreas, common bile duct, or duodenal papilla may land the patient and surgeon in this dilemma, but these diseases generally run a rapid course and end fatally in a few months, even when the jaundice is relieved by short-circuiting the bile into the intestine or by draining it away on to the surface of the body.

We need not therefore hesitate to remove the gall-bladder for any just cause, such as disease limited to the gall-bladder and the cystic duct, provided that the operation can be done without undue risk. Its chief rival is cholecystostomy, cholecystotomy being hardly worth considering.

The question is more conveniently discussed under two

headings, according to whether the disease is limited to the gall-bladder or not.

(1) WHEN THE DISEASE IS LIMITED TO THE GALL-BLADDER
AND CYSTIC DUCT

Increasing knowledge and experience of the surgery of the gall-bladder, and especially of the ultimate results of a very large number of these operations compel us to change our original estimates of the relative merits of cholecystectomy and cholecystostomy. It has been a common belief that draining is always much safer than excising a diseased gall-bladder, but experience proves that *with a proper selection of cases* the reverse is often true. Thus the mortality in 2498 cholecystectomies, performed at the Mayo Clinic between 1907 and 1916, was 1·3 per cent. and that of 2854 cholecystostomies was 1·5 per cent.²

Moreover the convalescence and ultimate results of cholecystectomy are very much more satisfactory in every way. After cholecystostomy, recurrence of symptoms and secondary operations are infinitely more common. This is what we should expect, for nearly all gall-stones are formed within the gall-bladder, and are secondary to pathological conditions affecting it, which, although ameliorated, are not often cured by drainage, for the primary disease, generally infective in nature, is in the walls of the gall-bladder, in which micro-organisms have been shown by Rosenow³ to persist indefinitely after drainage. This chronic cholecystitis may cause recurrence of cholelithiasis, recurrent acute attacks of inflammation, secondary reflex and infective changes, especially in the stomach, duodenum, and pancreas, thus setting up chronic dyspepsia and even ulceration of the stomach and duodenum, and also chronic or acute pancreatitis. Chronic septic absorption from the gall-bladder is an occasional source of infective arthritis and fibrositis or "muscular rheumatism," which may lead to serious disablement and deformity.

Patients are frequently very dissatisfied after cholecystostomy on account of recurrence of symptoms, biliary or mucous fistula, mucocoele, and empyema of the gall-bladder. Jaundice, either intermittent or chronic, may develop, due to stones overlooked or re-forming in the gall-bladder and travelling into the common bile duct, or due to the stricture or kinking of the common bile duct owing to the fibrosis and contraction of a gall-bladder adherent to the anterior abdominal wall. In some cases the infective condition of the gall-bladder spreads into

the bile ducts and sets up infective cholangitis, or in suppurative cases it may spread into the portal veins causing pylephlebitis. Adhesions forming between the gall-bladder and the pylorus and duodenum not uncommonly cause stenosis and delay in emptying the stomach.

Another reason for removing a diseased gall-bladder is that it may be the seat of early malignant disease, which can sometimes only be discovered by microscopical examination after it has been removed. Sherrill ⁴ draws attention to the frequency of this complication in late cases, and the present writer has been surprised to find unsuspected early carcinoma in gall-bladders, which he had removed for cholecystitis, with or without cholelithiasis. The hope of cure in these early stages of cancer is very good. One of my patients, operated on ten years ago, is still in good health. Moreover, our experience of the evil influence of chronic inflammation on the incidence of malignant disease here and elsewhere teaches us that the risk of the subsequent development of carcinoma in a chronically inflamed gall-bladder is worth serious consideration and should induce us to remove the diseased gall-bladder whenever it is possible to do so without undue risk.

It is clear that cholecystectomy is more radical and generally satisfactory than cholecystostomy, but it is not always the easier and safer operation. When the patient is very ill, old or feeble, when the gall-bladder is very inflamed, distended, and adherent, the surgeon, especially if he is not very experienced in this branch of surgery, will be wise to choose cholecystostomy.

Incidentally it is right to say that the surgery of the bile apparatus, like that of the stomach and duodenum, is not to be lightly undertaken by the amateur or the novice. The interests of the patient, as well as the good name and honour of Surgery, demand special skill and experience from the surgeon who undertakes this work, for it is impossible to tell what difficult and unexpected problems may present themselves and have to be promptly solved when the abdomen is opened. These operations, sometimes so easy, may, on the other hand, frequently be among the most difficult and hazardous in surgery. When medical men realise these facts, we may hope to see fewer bad results and secondary clearing-up operations, such as cholecystectomy, and choledochotomy for the removal of stones left in the common bile duct, and the repair of fistulae or strictures following injuries of the bile ducts.

(2) WHEN THE DISEASE IS NOT LIMITED TO THE GALL-BLADDER
AND CYSTIC DUCT

There is more room for doubt about the indications for cholecystectomy when the disease, especially cholelithiasis, has extended into the main bile ducts. It is evident that the gall-bladder should not be removed unless it is certain that the common bile duct is patent and likely to remain so. It is also clear that it is too risky to be undertaken when the patient is very ill, old, or feeble, and especially in the presence of jaundice which has lasted long enough to diminish the coagulability of the blood—as shown by a previous estimation of the clotting period—thus adding the possibility of uncontrollable bleeding to the dangers of the operation. No one, again, would suggest the removal of the gall-bladder when infective cholangitis exists, for, in this grave condition, the only justifiable operation is the removal of stones and the drainage of the common bile duct, and even this should, if possible, be deferred to a quiescent period when the risk is much less.

Under favourable conditions, however, when the bile ducts are patent, it is very advantageous to the patient to have the diseased gall-bladder removed and thus to be saved from the probable recurrence of symptoms with or without a subsequent radical operation.

CONCLUSIONS

The chief indications for cholecystectomy are irreparable wounds, injuries or diseases of the gall-bladder and its duct, in cases where the bile duct is healthy and patent. The following are the most important of these diseases :—

Acute or chronic cholecystitis.

Gangrene.

Perforation, with or without cholelithiasis.

Empyema, hydrops, or mucous fistula of the gall-bladder due to obstruction of the cystic duct by stone, kink, or stricture.

Papilloma, or carcinoma of the gall-bladder.

Volvulus of the gall-bladder.

Biliary fistula or chronic jaundice, due to kinking of the common bile duct following cholecystostomy.

It is not wise, particularly for a surgeon without special experience, to undertake this operation in cases where the patient is very ill, old, or feeble, or when the mechanical

difficulties of the operation are great. Neither should it be attempted when there is jaundice of some weeks' duration, with consequent risk of hæmorrhage, nor when there is infective cholangitis.

Cholecystectomy should never be performed unless it is certain that the common bile duct is patent.

THE OPERATION OF CHOLECYSTECTOMY DESCRIBED IN DETAIL

A rubber pillow is placed under the patient's back at the level of the liver, for this opens out the costal angle, making the parts more accessible, bringing the bile ducts much nearer the surface and displacing the intestines downwards, away from the liver.

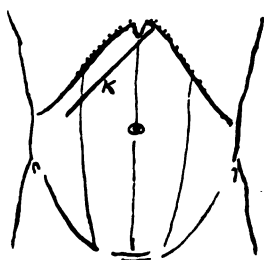


FIG. 1.

Kocher's incision, K. All the fibres of the right rectus but no nerves are divided, although the incision may be prolonged across the linea alba and outwards into the external oblique muscle.

The patient's head is raised and the thighs somewhat flexed to relax the recti. With the same object Kocher's incision is chosen (Fig. 1). This starts just below the tip of the ensiform cartilage and runs obliquely downwards and to the right, one and a half inches below the costal margin. It descends a little towards its outer end and completely divides both the muscular fibres and the fibrous sheath of the right rectus muscle. Cutting across the rectus sheath gives far better access than vertical slitting. If necessary the incision may be prolonged slightly into the muscular fibres of the external oblique without dividing any of the

intercostal nerves. This gives a direct and wonderful view, almost abolishes the need of retractors, and its lower edge keeps the intestines from prolapsing. Hernia is very rare after this incision even when drainage has to be adopted.

Every bleeding vessel is immediately tied with fine cat-gut and the transversalis and peritoneum are incised freely. The falciform ligament is also clamped and divided if necessary. The abdomen is rapidly explored, unless there is some contra-indication, and the whole biliary apparatus is always carefully examined, for it is vital to determine if the common bile duct is normal, to see if its first part, above the duodenum, is dilated or not, and to palpate its second and third parts, the head of the pancreas and the duodenal papilla for stone, induration, or growth (Fig. 2).

If the disease is limited to the gall-bladder and its removal

is considered, after due deliberation, to be both necessary and wise, the liver is displaced downwards and rotated, if possible—a gauze pack being placed above and behind it, if necessary, to retain it in this advantageous position. A dry gauze roll is carefully packed into the right kidney pouch and a large aseptic pad, with tape attached, is inserted at the inner part of the wound to protect the stomach and duodenum. When the gall-bladder has been carefully freed from adhesions to the omentum, colon, or duodenum, its fundus is seized with forceps and drawn forwards by an assistant while the surgeon exposes the cystic duct by incising the peritoneal fold extending from the gall-bladder to the front margin of the foramen of Winslow. When the gall-bladder is large, distended, and folded downwards awkwardly at the neck it is first emptied with a trocar.

Careful blunt dissection soon displays the duct, and, to avoid any chance of error, this must be followed to its junction with the common bile duct, which must be clearly displayed.

When the cystic duct has been dissected out of its bed, it is tied with cat-gut about a quarter of an inch from its termination, and divided, between the ligature and a firm, long-handled, curved clamp which prevents leaking from the gall-bladder and is useful for gentle traction. The cystic artery and vein are similarly isolated, tied, and divided as they pass forwards between the cystic duct and the liver. The greatest care is necessary to avoid clamping or wounding the common hepatic duct and especially its right tributary. It is all too easy to injure these, particularly if the gall-bladder is distended, folded at its neck, and the connective tissues in the fissure are inflamed, œdematous or indurated.

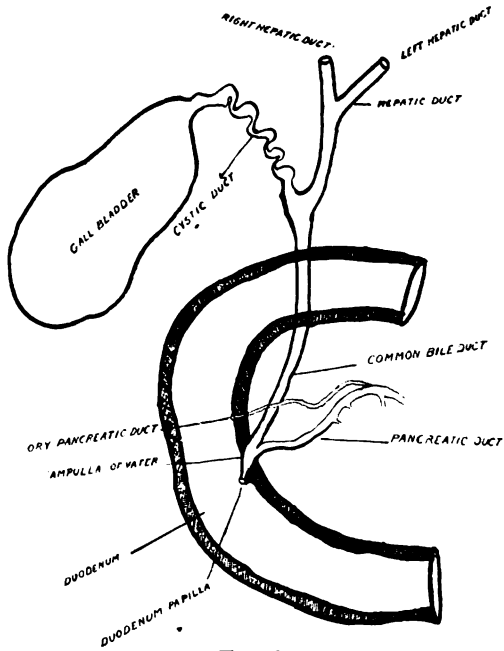


FIG. 2.
Anatomy of the biliary apparatus.

The gall-bladder is now separated from the liver from behind forwards, by blunt dissection with the finger. The peritoneal covering is saved, as far as possible, until the separation is nearly completed. It is then so divided with scissors that the edges can be sewn together to cover the raw surface of the liver. This arrests hæmorrhage from the liver and minimises adhesions.

Occasionally, when there are very dense adhesions about the neck of the gall-bladder, it may be safer to separate it from before backwards, but as a rule this is more tedious and causes more bleeding.

The stump of the cystic duct is buried and the raw surface of the liver covered by sewing the flaps of the peritoneum over them. Unless all oozing has been stopped it is wise to drain the wound with a small, soft rubber tube for thirty-six hours.

The air is released from the rubber cushion, and the parietal wound is accurately closed in layers.

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SOME CASES OF QUININE AMBLYOPIA AND NOTES ON ITS PATHOLOGY

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THERE still seem to be some who doubt whether among the large number of cases of malaria treated during the war, blindness occurred as a result of the taking of large doses of quinine. I quote the following from the *British Journal of Ophthalmology* (p. 300, 1919), written from abroad, regarding quinine amblyopia: "After over three years of ophthalmic work, and with thousands of cases of malaria and hundreds of thousands of men taking quinine, there has been no case of quinine amblyopia, and neither have I heard of one at any of the other hospitals." It was reserved, however, for an ophthalmic surgeon at a home hospital to see more of the results of quinine-taking in its effect on the eyes. I can no longer have any doubt as to the fact of its occurrence, even though it be rare, as I personally had 6 cases at the 2nd London General Hospital during the years 1915-1918. Notes on these I now append, with comments on certain points, which I think are not yet sufficiently and satisfactorily explained by any theory elucidating the pathological sequence.

CASES OF QUININE AMBLYOPIA

Case 1. Pte. E. N., *wt.* 38, of the 8th South African Infantry, was for fifteen months (1915-1916) in German East Africa, where he had malaria and was given quinine intramuscularly. He first noticed some loss of sight in March 1917, and saw Dr. Brunton of Johannesburg for this, who told him it was due to quinine poisoning. He was afterwards sent to England on account of his blindness, and admitted to the 2nd London General Hospital in 1918. On examination, I found optic atrophy in both eyes; both optic discs were pale, and the arteries were small and ensheathed. His fields of vision were very contracted, and his visual acuity only equal to the discernment of large moving objects.

When in St. Dunstan's, his ears were examined by Mr. W. M. Mollison, who reported:

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Right Ear: Membrane opaque.

Left Ear: Large post perforation—moist.

His tonsils and adenoids were removed at Guy's Hospital.

Case 2. G. S. H., *æt.* 41, had lived in South Africa since he was 20. He first had malaria in 1901, and frequently took quinine, sometimes as much as 40 grs. within an hour; he was taking 30 grs. a day regularly at the time he was attacked with quinine-blindness. He had been demobilised only five weeks, and was very run down and depressed. In May and June 1919 he was given kharsivan, and was discharged from the Army on July 11, 1919.

Notes by Dr. Wood of Cape Town, July 27, 1920.—“Lieut. H. took 30 grs. of quinine on the evening of September 2, 1919. He became dazed and sick afterwards, and at midnight found that he could see nothing. This continued for five days, but when he came to me on the 8th he had seen some objects in fleeting glimpses. The pupils were dilated and only just moved under light; the retinae were œdematous looking, and the vessels small; no visible breaks in the blood stream were seen. He had bare perception of light. By December 2 each eye had 6 36 and together he got 6 24. His field of vision was a circle of about 20 degrees round the fixation point. In January 1920 he was rather worse, the fields being smaller on the inner sides. In February his vision was 6 36 only, and he complained of “rolling clouds.” He had been for some time on strychnine and strophanthus, and was now put on high frequency for ten minutes daily. On March 5 he was much better, except that distant objects were seen as “white hot.” He read on that day 5 12, and the mists were less permanent. In April he was put on diathermy to try to get a better retinal circulation, but there was a slow retrograde movement, so that in June he had only 3 60 vision. At the present date July 27, 1920 he is not worse, and sees a few letters of 5 30 and 2 10. Apparently he has difficulty with the larger letters because they are larger than his field of vision. He tells me, however, that sometimes he gets glimpses of objects at the side.”

The knee-jerks are present, and optic discs white. The retinal vessels are very small and enshathed.

Vision of both eyes = 3 60 badly. Minute fields.

Prof. E. J. N. Cox, September 16, 1920.—I saw this patient yesterday and took blood for a Wassermann, and obtained a completely negative result.

I searched slides for malarial parasites, also with a completely negative result.

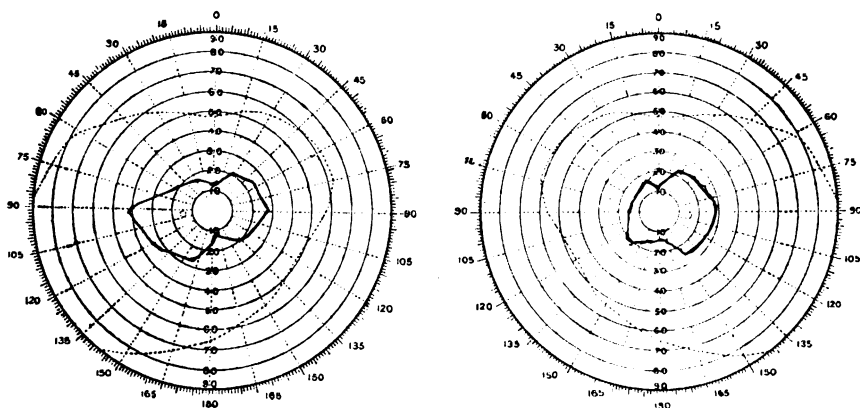
His differential leucocyte count seems to be a little peculiar, and is as follows:

P. lymphocytes	48 per cent.
Eosinophiles	5 ..
Lymphocytes	43 ..
Large mononuclears	4 ..

1921.—The vision has failed almost completely in spite of treatment, and now he barely sees light. The optic discs are white, the vessels minute and in places replaced by white lines, and his pupils dilated and fixed.

Case 3. W. C., Pte. A.S.C., *æ*t. 23, was treated for malaria in Salonica, where he had about eight intramuscular injections of quinine. He took 60 grs. of quinine by mouth per diem for five successive days, after which he complained of headache and of spots before his eyes. On November 26, 1918, the note made was: the vision in the right eye was 6/6, and in the left 6/9. His arteries are small, but the retinal veins do not seem markedly altered. The fields of vision are very contracted.

Case 4. Capt. P., *æ*t. 29. This officer was attached to the Munster Fusiliers during August 1917, and was treated at



Salonica for malaria. Whilst there he was given on one day (November 29, 1917) 15 grs. of quinine intramuscularly. The same evening he had a rigor and became unconscious, and was then given 20 grs. in the same way. As his condition did not improve, other injections followed at 12.40 a.m., at 5.30 a.m. and at 10 a.m., the last dose being given intravenously. It is doubtful as to the exact amount he had during the twenty-four hours, but apparently something between 80 and 100 grs. His general condition due to the malaria improved after this, and he was sent home on account of his eyesight.

The note made in Malta, where he was seen on his way home, was that the papillæ were pale grey, and the retinal arteries in the right eye were so constricted that their course was invisible at certain points, but were readily seen when they crossed the papilla. The veins were but little constricted, and in the left fundus the arteries were extremely fine but visible throughout their course. The pupils were widely dilated, with only a slight reaction to light. Perception of light was doubtful. On

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January 19, 1918, he was sent to England, where he arrived in ten days' time. The note made at the 2nd London General Hospital on January 31, 1918, was as follows :

$$R. E. \bar{c} - 1.25 = 6/6$$

$$L. E. \bar{c} - 1.25 = 6/6$$

The arteries are very small, the fields of vision very contracted (*vide* Chart); the pupils are dilated, but react to light.

Case 5. Driver W. H., *æt.* 21, A.S.C., came from 67th Hospital, Salonica, on November 21, 1917, and was in the 2nd London General Hospital during the early months of 1918. In 1917 he had malaria, and quinine was given. On examination in February 1918, I found both his pupils reacted to light, but the optic discs were white and the arteries very small. There was some ensheathing of the vessels with white streaks radiating along the vessels from the optic disc as centre. The vision of his right eye was 6/12 and that of his left 6/9, with very contracted fields. The white lines seen radiating from both optic discs were contracted arteries, and a minute red streak could be seen in the centre. His blood was examined on November 1, 1917, with negative results, and again on November 2, 1917, when numerous small rings were found. A lumbar puncture on November 2, 1917, showed no organisms in the cerebro-spinal fluid; a blood examination was made on November 3, 1917, when no parasites were found. In November, an "up and down" temperature of 99 to 104 degrees was recorded, which became more normal in five days. In October 1919 he was seen again at St. Dunstan's; then both optic discs were white, and the retinal vessels, especially the arteries, were minute, and numerous white streaks showed along the course of the vessels. Retinitis proliferans?

He could not then see to get about, and his vision seemed to be much worse than formerly. He could only see large objects in front of him: the pupils reacted to light, but sluggishly, and his general physique was only suggestive of C3.

Case 6. Sgt. A. G., *æt.* 38, of the 6th Royal Irish Rifles, was stationed at Salonica in 1917, where he had four to five attacks of malaria and was given quinine three times a week. When seen at St. Dunstan's in 1918 the following note was made: optic atrophy is present on both sides. He can see light and dark, but his fields of vision are very small, and there is some ensheathing of the retinal vessels.

He was treated at the Royal Westminster Ophthalmic Hospital with injections of strychnine, and the record from that hospital states that the vision improved for a time under treatment.

17.10.18.—V. R. E. 3 60. V. L. E. 3 36.

27.10.18.—V. R. E. 6 18. V. L. E. 6 12.

7.11.18.—V. R. E. 6 36. V. L. E. 6 24.



This improvement did not last, and his vision failed in 1919 to less than 6/60 with either eye, and the fields of vision were contracted to within 10 degrees of the fixation point.

THE TOXIC DOSE OF QUININE

With regard to the question of the minimal dose of quinine which produces pathological symptoms in the eyes, Elliot¹ records a very interesting case in which 2 grs. of quinine produced definite ocular symptoms in a patient with an idiosyncrasy to quinine, contracted arteries and contracted fields of vision being well marked three quarters of an hour after taking the dose. Traquair² records 3 cases in which comparatively small doses were responsible for toxic symptoms:—

(1) 2–3 grs. per diem were taken for three weeks, and then a single dose of 20 grs.;

(2) 15 grs. of quinine (urea hydrochloride) were taken every four hours for thirty-six hours (120 grs.);

(3) 2–5 grs. of quinine (in cachet) every four hours for one night (a total of less than 20 grs.).

In the cases seen by me during the war, the amount of quinine taken is difficult to estimate from the rather meagre notes sent with the cases and the still vaguer account of the men, but apparently all had had much larger doses than those recorded above.

De Schweinitz records a case of temporary amblyopia following the taking of 12 grs. of quinine by a neurotic woman, and Collins and Mayou³ state that the minimum dose recorded is 5 grs. in thirty-eight hours.

No doubt certain individuals show a marked idiosyncrasy towards this drug, but its toxic effect is more likely to be produced in debilitated and cachectic patients. This is comparable to the retinal ischæmia produced by severe loss of blood in certain weakened patients, a condition almost entirely unrecorded in the war; probably because when large amounts of blood were lost as the result of severe wounds, the victims were for the most part young healthy men, in fit condition.

SYMPTOMS

In mild cases of quinine poisoning the visual disturbances may be only temporary, but in more severe ones the clinical and ophthalmoscopic symptoms are generally well marked and permanent. The amblyopia is always bilateral. Within a few hours of the taking of the dose, tinnitus, deafness, delirium or excitability, and blindness ensue, with marked cerebral symptoms, collapse and insensibility. The pupils are widely dilated and inactive,

the retina cedematous, the vessels contracted and obscured, and the optic discs pale. Sometimes an appearance is seen similar to the "cherry-red" spot found in embolus of the central retinal artery.

Central vision usually recovers first, whilst the field of vision remains contracted. This central vision may improve, or may later on again be lost, so that complete atrophy ensues in some weeks or months.

A case of defective vision due to quinine poisoning shows some months after, a white atrophic optic disc, very constricted arteries with white lines edging the vessels, contracted fields of vision, and central vision only (if there is sight at all), so that, although the patient may have a visual acuity of 6/9, or even 6/6, he is unable to get about alone, owing to the constriction of his fields of vision.

We remark (1) the initial loss of sight; (2) a partial recovery; and (3) a subsequent failure which may leave the patient diminished sight, or even none at all. After a lapse of one or two years the changes in the eyes are almost stationary. A case recorded by Weeks,⁴ originally seen by Herman Knapp, and examined by Weeks after an interval of thirty-eight years, showed hardly any alteration, although some slight degeneration had occurred as well as nystagmus.

PATHOGENESIS

There are several interesting points in the pathology of quinine poisoning which require to be discussed.

Quinine blindness, though rare, does undoubtedly occur, but does quinine normally produce any definite retinal changes in patients taking large doses? No records of such cases, or hardly any, are forthcoming. Probably no change takes place as a rule, and consequently we must assume that certain individuals have an idiosyncrasy to it, as even very large doses do not in the majority of cases produce any retinal changes.

Some observers have recorded a "negative" phase—that is a period when with profound visual defect the ophthalmoscope shows no change in the retina. This stage may or may not always occur—it certainly is transient and usually appears very early. Many more writers record definite ophthalmoscopic changes when the vision is profoundly altered, and still more interesting is the fact that they record that the vision may be improving whilst the ophthalmoscopic changes are becoming more and more marked.

(1) What, then, is the pathological cause of the amaurosis

without ophthalmoscopic signs, which is sometimes called the "negative" phase?

(2) What is the pathological cause of the early ophthalmoscopic appearance which has been likened to the picture presented by an embolus of the central artery, the contraction of the vessels and the white cloudy œdema of the retinal tissue?

(3) What is the cause of the late changes seen after two years or so?

(4) Why, when the vessels have contracted, do they remain contracted?

(1) The early amaurosis without ophthalmoscopic changes may be central and due to the effect of quinine on the cerebral centres, and on the optic nerve fibres themselves.

The absence of vision, the fixed dilated pupils and the accompanying cerebral symptoms, all suggest that the central nervous system is profoundly affected; also the deafness is probably, in part, of central origin.

The effect on the central nervous system must be due to a direct action of the quinine on the nerve cells or neurons. No other explanation seems possible. Quinine acts on nearly all forms of living protoplasm, and there can be little doubt but that it powerfully affects the delicate cells of the brain.

In C. R. Marshall's article on "Quinine" in Hale White's *Pharmacology*, I find experimental evidence adduced to prove that the effect of quinine on the white blood corpuscles is to inhibit their movement, and cause them to line up on each side of the vessel wall, forming a row of coarse granules.

Quinine acts on all protoplasm (and white blood corpuscles may be looked upon as pure protoplasm), on the slightly differentiated variety causing malaria, as well as on the highly differentiated form found in the brain; it retards its oxidising power. After absorption quinine circulates in the blood in a state of solution, probably in the form of a carbonate.

The central nervous system, being a highly specialised system, is particularly sensitive to this so-called protoplasmic poison, and the first symptoms produced by this class of poison are invariably nervous, either giddiness, headache or excitability. We must remember that the optic nerve is a part of the brain. The early onset of deafness and noises in the ears suggests that this rapidly developed symptom is due partly, at any rate, to central causes, although definite peripheral changes are recorded; and it is the same with the eye.

(2) Although the first early symptoms of general mental disturbance and blindness without ophthalmoscopic changes

are, in my opinion, of central origin, we find definite peripheral changes in the eyes.

We must assume from the findings of numerous observers, and particularly from Elliot's direct observation, that quinine poisoning does produce contraction and spasm of the retinal vessels, in spite of the fact that the physiological action of the drug causes dilatation of the blood-vessels and a fall of blood pressure. It was stated by de Schweinitz some years ago that "the gaps in our knowledge of the pathology of experimental quinine amblyopia have now been filled, with one exception, viz., the cause of primary contraction of the retinal vessels, which creates the ischæmia."

The gap has been enlarged rather than closed since that was written.

The results of Holden's⁵ experiments on dogs, to which toxic doses of quinine were given and which died or were killed at periods of from two hours to seven weeks after the first injection, were summed up by him as follows:—

"Although the arteries were constricted, no histological changes were noticed in the vessels of the nerve or retina in any case, there being neither thickening of the vessel-walls nor proliferation of the endothelium. The thin-walled central vein of the optic nerve was often found to be empty and collapsed, and the delicate connective tissue about it, with its small vessels, owing to its being stretched and apparently increased in amount, sometimes suggested the appearance of an organised thrombus in the vein, but this same appearance was noted also in healthy dogs when the vein was empty.

"The pathological process, then, consists in a constriction of the retinal vessels, and particularly of the arteries, followed by a highly albuminous serous exudation into the nerve-fibre layer, and a degeneration of the ganglion cells together with their axis-cylinder processes, which become the centripetal fibres of the optic nerve. There is no way of determining exactly how far the degeneration of the ganglion cells and their axis-cylinders may be due to the *direct* toxic action upon them of the cinchonised blood, and how far the degeneration may be due to the *indirect* toxic action of quinine in constricting the retinal vessels, and thus reducing their nutritive supply.

"Clinically it is found that amblyopia does not occur unless the injection of quinine produces marked constriction of the retinal arteries. The pathological changes are analogous to the degenerative changes which follow so-called retinitis of the inner layers. The retinal vessels nourish the six inner layers of the retina, the other layers being supplied by the choroidal

vessels. Disorders of the retinal vessels cause degeneration of the inner layers, followed by an ascending atrophy of the optic nerve. This degeneration is seen most clearly after the complete stoppage of retinal circulation by embolism of the central artery, and after long-continued circulatory disturbances in cases of chronic glaucoma. The nerve fibres, ganglion cells, and the cells of the inner nuclear layer then all disappear, while the outer nuclear layer, the rods and cones, and the pigment epithelium, making up the outer layers of the retina, remain intact. With reduced, but not abolished, nutritive supply in quinine poisoning, the more delicate elements of the inner layers, that is, those most responsive to nutritive disturbances, namely, the nerve fibres and ganglion cells, break down and disappear; while the less delicate elements, the cells of the inner nuclear layer, are not perceptibly altered. From analogy it would seem justifiable to assume that the changes in the retina in quinine amblyopia are due chiefly to deficiency of nutritive supply, and, to a lesser degree, to alteration in the quality of the nutritive supply."

We see, then, that as far as the pathological evidence goes, there is no permanent change or alteration in the blood-vessels. The initial change is one of spasm, and apparently this passes off within a limited time, leaving the vessels unaltered so far as any evidence can be adduced by microscopical examination. With regard, however, to the cellular elements of the retina itself, profound and generally permanent changes take place. These changes are most marked where these same cellular elements are dependent upon the central retinal arteries for their nutrition, but no unequivocal evidence exists to mark which cause operates most effectively, whether the poisoning property of the blood itself or the interference with their nutritional source.

It seems to me to be consistent with the clinical facts to suppose that the cellular elements are depressed by the interference with their nutrition first of all, and remain so as long as the circulation remains abnormal, but that on the recovery of the circulation the cellular elements also show increased functional power, as shown by the improvement in vision.

(8) In severe cases, however, the cellular elements have been damaged beyond recovery by the toxic property of the cinchonised blood, and atrophy of the cellular elements eventually occurs, producing an ascending atrophy of the nerve fibres, and, later still, a permanent diminution of the vascular supply, such as is found in all atrophic tissues; but this last change does not appear until many months later.

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(4) The ensheathing so frequently noticed lining the vessels, especially the arteries, is due to changes occurring in the lymph spaces, which accompany the vessels everywhere. Experiments on animals show that quinine produces an arrest of diapedesis, and the wandering leucocytes are brought to a halt outside the vessels by the presence of the cinchonised blood within the vessel walls. These cellular elements probably increase enormously, are altered and eventually become organised into fibrous tissue, which lines the outside of the vessel and produces an *apparent* contraction of them as seen by the ophthalmoscope, since the opaque tissue overlaps the vessel walls and the red blood stream seen through the opaque wall looks small and thin. I would suggest that at one stage of quinine amblyopia the frequently reported extreme constriction of the retinal vessels is sometimes only apparent, and that permanent real constriction is a much later phenomenon, due to a real and permanent optic atrophy supervening.

The early ophthalmoscopic signs, resembling embolus of the central retinal arteries, are due then to a spasm of the vessels, resulting in a partial coagulation necrosis of the inner retinal layers. The spasm does not persist permanently, but relaxes, and the contracted appearance of the vessels is apparent only, and is suggested by the ophthalmoscopic appearances caused by arrested diapedesis due in the first instance to the quinine, but which results in permanent ensheathing of the vessels. The last stage, when permanent contraction is a reality, is consequent on the optic atrophy which is the final result of the condition.

It is obvious that the changes are not complete in all cases, and that the differences of vision recorded in different patients are due to the disparity in dose of the poison and of the reaction of the individual cells.

It has been suggested that quinine has a selective action on the rods of the retina, as the area served by the rods is that most profoundly affected, and the patients display rod-blindness, but the interference with vision, due to a constricted vascular supply, would affect the periphery of the retina to a greater extent than the central portion, the rods being in greater number in the periphery and the cones being more numerous at the centre. It may be, however, that quinine does affect the rods most of all, and has some selective action on them.

The whole subject of quinine poisoning is of the very greatest interest, and still defies complete elucidation, but I

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venture to think that the facts of its existence ought to be more widely known, now that heroic doses of this drug are being widely advocated in the treatment of malaria.

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A CASE OF EXTERNAL OPHTHALMOPLEGIA DUE TO SUPPURATION IN THE MAXILLARY ANTRUM: OPERATION: RECOVERY

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THE connection between suppuration in the nasal accessory sinuses and lesions in the orbit has long been recognised, but the paths by which infection passes are still uncertain.

The course of infection may be (*a*) direct spread through the bone, as frequently occurs when orbital cellulitis complicates frontal sinus suppuration; (*b*) by the small blood vessels (actually this form of spread is probably a precursor to the bony spread); (*c*) by the lymphatics; about this, knowledge till recent time was very scanty.

Piersol's "Anatomy" states that no lymph vessels have as yet been described as occurring in the orbital tissues. More recent work goes to show that it is most probable that lymphatics do exist in the orbit, perhaps in the neighbourhood of the muscles. Dewey¹ has used vital staining, and believes there are probably lymphatics running along the muscles.

Attacking the question from the point of view of the nasal accessory sinuses, Mullin and Ryder² injected Indian ink into the antra of rabbits and examined the nose, glands, orbit and lungs some days later. In only one case, in which the injection had been accidentally made into the antral lining under considerable pressure, were the granules of ink found in the orbit and round the optic chiasma.

That there must be lymphatics in the orbital tissues is strongly supported by the following case reported by Gradle.³ A cavernous lymphangioma of the right orbit occurred in a child of seven and presented as a swelling in the lower part of the orbit, displacing the eye-ball upwards; after removal, microscopical examination proved the lymphatic nature of the tumour.

Unless there be some lymphatic connection between the maxillary antrum and the orbit, as is suggested by the above,

ocular lesions as a sequel to suppuration in the antrum are difficult to explain. Perhaps the most obscure are those of paralysis of ocular muscles due to sinus suppuration.

As far as we could discover, but few of such cases have been recorded. Stucky⁴ reported a case of external ophthalmoplegia, in connection with suppuration in the frontal sinus, ethmoid cells and maxillary antrum, completely relieved by Killian's operation on the frontal sinus. Posey⁵ quotes a similar case. The following case seems one of considerable interest, as showing that maxillary antral suppuration can cause paralysis of the external rectus muscle.

W. H., aged 55, attended the Ophthalmic Department in January 1921, complaining of diplopia. He stated that from January 5 he suffered from pain in and about the right eye for some five or six days; he then noticed that he saw double. He managed to continue his work as a wheelwright, but found it easier if he wore a shade over the right eye. On examination complete paralysis of the right external rectus was found: all other muscles moved normally. There was no optic neuritis.

On account of the painful onset (an unusual symptom), an inflammatory origin was suspected, and the patient was referred to the Throat Department. Examination of the nose revealed pus in the right middle meatus and exploration was advised. Operation was performed on March 10. Pus was withdrawn from the antrum by means of a needle and syringe, and an intra-nasal drainage operation was completed; the anterior end of the middle turbinal was removed and the fronto-nasal duct gently curetted.

Recovery of muscular movement did not occur till two months later, and then did so rapidly; thus on May 3, the muscle was still paralysed, while a week later the eye moved outwards, and by May 20 recovery was complete.

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CÆSAREAN SECTION IN GUY'S HOSPITAL. 1910-1920

By ARTHUR J. McNAIR, M.B., Obstetric Registrar, Guy's Hospital.

PERHAPS the greatest change in the practice of obstetrics during the last ten years has been the much more frequent adoption of Cæsarean section as a means of delivery. The operation is resorted to with such comparative freedom at the present day that it has appeared to many observers that there is a danger of its too indiscriminate use as an easy means of escape from all the difficulties in midwifery. In order that its results, immediate and remote, may be carefully inquired into a collective investigation is now being made with the co-operation of most of the obstetric surgeons in Great Britain and Ireland. For this purpose the Guy's Hospital statistics have been prepared and submitted.

Much useful information is to be expected from the consideration of the very large number of cases which will be reported, and there can be no doubt as to the value of deductions drawn from so great a mass of material. The publication of the report on this inquiry is awaited with interest.

It is felt, however, that this would be a suitable opportunity to examine the subject with reference to the practice at Guy's Hospital, because in the selection of cases and in the actual technique of the operation a more definite tradition has been followed. This paper is based upon 121 cases of Cæsarean section which were under the care of the late Mr. J. H. Targett, Mr. G. Bellingham Smith, and Mr. Harold Chapple between the years 1910 and 1920 inclusive. The writer has to thank the last-named surgeons for permission to refer to their cases, and especially for their ready advice and assistance in this attempt at a critical review.

In accordance with the customary limitation of the term "Cæsarean Section" to operations performed after the foetus is viable, a number of cases are excluded in which the pregnant uterus was emptied by abdominal section before the twenty-eighth week of gestation, and a few instances of vaginal Cæsarean section are not considered.

In the Appendix * will be found brief notes set out in tabulated form of each of the 121 cases; when there is occasion to refer to cases of special interest fuller details will be given in the text. For convenience of reference the particulars in the Appendix are classified into four groups according to the nature of the indication for operation as follows—

Group I. Contracted Pelvis, Nos. 1 to 86.

Group II. Eclampsia and Toxæmias of Pregnancy, Nos. 87 to 94.

Group III. Ante-Partum Hæmorrhage, Nos. 95 to 100.

Group IV. Not included in Groups I, II, or III, Nos. 101 to 121.

The fourth group comprises a heterogeneous collection of cases, in which delivery of a living child by the normal processes of labour was considered impossible or hazardous.

It is proposed to analyse this series of cases with reference to

(A) the mortality of mothers and infants,

(B) the reasons for which the operations were performed, and

(C) the after-results of the operations; and to discuss

(D) the rôle of the operation of Cæsarean section in obstetrics, and

(E) the technique of the operation.

(A) THE MORTALITY OF THE OPERATIONS

Maternal Deaths.—In eight out of the 121 cases of Cæsarean section death of the mother occurred. It will be generally admitted that in the vast majority of the cases in which the operation is adopted the life of an unborn child is saved and that in many the death of a parturient woman is averted, but the question at once arises, “What is the operation risk?”

It is important to discover to what extent, if any, the surgical procedure is a direct or a contributory cause of a fatal issue.

In order to arrive at a true answer to this question it is reasonable to consider only those cases in which conditions were as nearly as possible ideal for the successful performance of the operation. If we exclude Groups II and III, in which immediate delivery was demanded on account of grave illness of the mother, there remain 107 cases in which the indication was, in the main, some obstruction to natural birth. If this

* The Appendix of cases referred to in this article will be bound with the Obstetric Reports for the year 1920. It can be inspected at any time on application to the Obstetric Registrar, Guy's Hospital.

total be further considered it is possible to differentiate between those cases in which operation was premeditated and those in which it was in the nature of an emergency. In the first class are eighty-five patients submitted to operation before, or within four hours of, the onset of labour; they were already in hospital or were admitted soon after labour had begun. Of these eighty-five patients one died: a mortality of 1·2 per cent. The fatal case in question is No. 45.

M. C., aged 33: 1 para. Contracted pelvis. The usual conservative Cæsarean section was done at full term after due preparation. Labour had not begun. A living child was delivered. Death occurred on the fifth day from peritonitis; there was no uterine infection, and the abdominal incision was healing soundly. The source of the infection was not traced; it can only be attributed to some accidental contamination at the time of operation. It may therefore be stated that the risk of a Cæsarean section done in favourable circumstances is only such as is inseparable from major surgery in general.

On the other hand, of twenty-two patients in the "emergency" class four died: a mortality of 18 per cent. These were cases of obstructed labour, in many of which no alternative mode of delivery was available, though the probability of infection was strong.

Infant Mortality.—From the 121 cases in the series 123 babies were delivered: there were two sets of twins. Nine of the infants were stillborn from causes indicated below—

No. 30. Obstructed labour: pelvic contraction. Attempts at forceps delivery.

No. 50. Obstructed labour: pelvic contraction. Attempts at forceps delivery.

No. 87. Eclampsia.

No. 91. Eclampsia. Twins.

No. 92. Toxæmia. "Pre-eclamptic symptoms." One twin dead.

No. 96. Ante-partum hæmorrhage.

No. 106. Missed labour. Macerated fœtus.

No. 113. Hydramnios. Macerated fœtus.

Of the 114 infants born alive nine died soon after birth. Four of these were definitely premature babies, and the mother of infant No. 98, which only survived for a few hours, had been operated upon on account of severe hæmorrhage. The children who left the hospital alive numbered 105.

The subsequent history of mothers and infants is dealt with in Section C, "After-Results of the Operations."

(B) THE REASONS FOR WHICH THE OPERATIONS WERE PERFORMED

Group I. Pelvic Contraction.—This was the reason for operation in more than two-thirds of our total. The majority of the patients had had experience of the disappointments and dangers of difficult prolonged confinements terminated by the extraction of dead infants. Their obstetrical histories are epitomised in the column headed “previous labours.” Many of these tragedies could have been prevented by skilled examination during pregnancy.

Cæsarean section was performed for the second time in twenty-two and for the third time in five instances.

It is valuable to emphasise again the significance of intra-uterine infection as it affects the outcome of a Cæsarean section. Of the total of eighty-six patients, seventy-one were operated upon before, or within four hours of, the onset of labour and before the membranes had ruptured. The only death is the one already recorded, No. 45, in which a chance exogenous infection is assumed to have been introduced at the operation.

Among the fifteen late operations for obstructed labour due to contracted pelvis three deaths occurred.

No. 20. L. S., aged 26, primigravida, was admitted after forty-eight hours' obstructed labour. A de Ribes' hydrostatic bag had been inserted and unsuccessful attempts had been made to deliver with forceps. Conservative Cæsarean section; uterine cavity infected and smelling; stillborn child. Death on fifth day from uterine sepsis, peritonitis, septicæmia.

No. 59. H. C., aged 18, primigravida. Twenty-four hours in labour before admission. Membranes ruptured; many examinations per vaginam; obstructed labour. Conservative Cæsarean section; living child. Moderate pyrexia in first week of puerperium; serious symptoms set in on seventh day; death on fourteenth day after transfer to a medical ward. Attributed to influenzal pneumonia. No autopsy.

No. 78. F. H., aged 33, primigravida. Pregnancy had been complicated with Hydramnios and labour at term had resulted in “Secondary Inertia.” Pelvis markedly contracted. Admitted thirty-six hours after onset of labour. A living child was delivered by Cæsarean section, and sub-total hysterectomy had to be done on account of hæmorrhage from the non-contracting uterus. Death on the fourteenth day from pelvic abscess, pneumonia, septicæmia.

If patient No. 59, who was thought to have succumbed to influenzal pneumonia, be included as a possible case of sepsis, the three cases quoted above can be considered together. It is noteworthy that they were all primiparæ, and that over

twenty-four hours elapsed in each case before the accoucheur in charge realised that natural delivery was impossible. Failure of the presenting part to enter the true pelvis should have led to their admission to hospital earlier.

In case No. 20 forceps had been applied and the foetus was dead. The degree of contraction was not such as to preclude extraction after craniotomy, and this course should have been adopted. When the uterus had been opened and found to be infected hysterectomy would have improved the prognosis, but the patient's doctor, who was present, decided that the extra risk should be run.

Group II. Toxæmia.—In cases Nos. 87 to 94 Cæsarean section was done on account of toxæmia. A fatal termination is recorded in cases Nos. 87, 88, and 91.

No. 87. E. B., aged 25, eclampsia at the thirty-fifth week of her first pregnancy. Eight fits preceded admission in the first stage of labour. Operation was performed twenty-four hours after the first seizure, when the patient was profoundly comatose. A stillborn infant was born. Death occurred half an hour later.

No. 88. M. J. G., aged 27, primipara, eclampsia at approximately full term; comatose and pyrexial on admission. Labour had not begun. A living child was delivered by means of Cæsarean section. This woman remained in coma with complete suppression of urine until she died on the fifth day. At autopsy the operation area was free from infection.

No. 91. R. P., aged 20, primipara, eclampsia, died a few hours after delivery of dead twins by Cæsarean section.

Eclamptics with less severe symptoms, Nos. 89, 91, and 93, survived operation with living children. A feature of one of these cases was the unusual association of very marked ascites.

No. 93. J. F., aged 26, primigravida, was admitted at the thirty-fifth week of pregnancy. She had been under treatment at home for one month for "pre-eclamptic" symptoms. Five fits occurred before and two after she was sent into hospital. At operation about five pints of fluid were let out from the peritoneal cavity. A living child was obtained, and the mother made a good recovery. Mr. J. H. Ryffel reported 0.77 grams of urea per 1000 in the blood and 10 parts per 1000 of albumen in the urine, and was of opinion that these findings were against a diagnosis of chronic kidney disease. Moreover, physical examination revealed no evidences of chronic nephritis. The heart was not hypertrophied, the retinae were healthy, and when she was discharged albumen had completely disappeared from her urine.

Included under the vague heading of "toxæmia" is another case which merits record.

No. 94. E. M., aged 25, primigravida, was admitted for extreme exhaustion following prolonged vomiting. At the sixth month of pregnancy she had been successfully treated in a medical ward for "hyperemesis" and had been discharged well. Shortly after returning home, however, vomiting had recurred, at first only in the morning, but later throughout the day, until on her readmission to Victoria at the thirty-fifth week all nourishment was being rejected immediately. She was exhausted and emaciated; her pulse-rate was persistently maintained between 130 and 140, and her urine contained a considerable amount of urobilin in addition to di-acetic acid and albumen. In spite of vigorous treatment of the condition of acidæmia by the administration of alkalies intravenously and of glucose rectally no amelioration of symptoms occurred. On the third day it was decided to terminate pregnancy, and a point which favoured abdominal section was the observation that the gravid uterus appeared to be displaced to the left by a smaller tumour on the right side. The possibility of some organic cause of intestinal obstruction was suggested. At the operation the cause of the asymmetry of the distended abdomen was at once apparent. The pregnancy occupied the left half of a uterus bi-cornis, while the unimpregnated right horn gave rise to the tumour which had been detected. The patient recovered.

Group III. Ante-partum Hæmorrhage.—This provided the indication for operation in cases Nos. 101 to 107. In three of these a placenta prævia, and in an equal number a normally situated placenta, was the site of bleeding. All the mothers survived, but living babies were born only in the placenta prævia cases.

No. 100 may be cited as an example of a case in which delivery by Cæsarean section was probably responsible for saving a mother's life and certainly prevented the loss of a much-desired infant.

E. M., aged 39, was pregnant for the first time after many years of married life. At the thirty-sixth week severe flooding from the uterus began without warning while she was asleep. She was admitted three hours later after a fruitless attempt had been made to control the hæmorrhage by the insertion of a pack of gauze through the cervix. As the cervix uteri admitted only one finger and was very rigid, immediate Cæsarean section held out the best hope of averting death from loss of blood. The operation was rapidly done under nitrous oxide gas and oxygen anæsthesia, and an asphyxiated child was delivered. The placenta was implanted in the lower segment of the uterus, and certain of the vessels of the umbilical cord, which had a velamentous insertion, were found to have been ruptured at the internal os uteri by the insertion of the tampon of gauze. This disposition of the vessels of the cord constituted the con-

dition of "Vasa prævia," and their laceration had resulted in direct hæmorrhage from the foetal circulation. The child was resuscitated and did well, and the woman recovered after a somewhat protracted convalescence.

For accidental hæmorrhage three Cæsarean operations were performed. In two of these bleeding was mainly concealed and was associated with albuminuria (Nos. 95 and 98), while in the other (No. 96) fibromyomata were the cause of placental separation. There were no maternal deaths, but all the babies were born dead.

Group IV.—The operation was decided upon for a variety of conditions in the twenty-one cases included in this group. In eleven instances the procedure was obligatory on account of insuperable obstruction by pelvic tumours, while in most of the others abdominal section was preferred because delivery by the natural route was rendered dangerous to the mother by some special circumstance. In the only case which ended fatally it was reasonable to make the interests of the foetus the paramount consideration, as the mother was moribund from incurable disease.

A. W., aged 40, was transferred from a medical ward in labour at the thirty-sixth week of her third pregnancy. She was suffering from advanced carcinoma of the stomach with secondary deposits in her pelvis which had led to fæcal impaction. The foetus was presenting by a shoulder, and could only have been delivered through the vagina after decapitation. A living child was born, but the mother sank and died on the fifth day.

The nature of the eleven pelvic tumours which complicated pregnancy was as follows—

Fibromyomata of the uterus, Nos. 102, 103, 104, 109, 115, 116.

Ovarian neoplasms :

Pseudomucinous cystadenoma, No. 114.

Dermoid cysts, Nos. 111, 112.

Fibroma, No. 105.

Secondary carcinoma, No. 107.

Of these, No. 105 is worth recording in some detail, because of certain unusual features and for the morals it points.

G. H., aged 23, was seen by Mr. Harold Chapple in consultation with her own doctor when her first confinement had already lasted five days. The membranes had ruptured forty-eight hours previously. A hard mass lay in the cavity of the pelvis simulating the head of a full-time foetus not only by its size, but because of a diamond-shaped depression upon it which had

been mistaken for the anterior fontanelle. The head of a foetus could be made out above this tumour by abdominal palpation. The patient was without delay admitted to Victoria Ward, where she was delivered of a living child by Cæsarean section followed by hysterectomy on account of infection of the uterus. The tumour was removed, and was found to be a fibroma of the left ovary partially calcified. It is now preserved in the Museum (spec. No. 5780). The woman recovered and was discharged with a healthy baby.

This case illustrates the importance of the careful routine examination of pregnant women, particularly primigravidæ, and the fallacy of depending solely upon examination per vaginam for the diagnosis of a presentation. It is also a good example of the class of case in which the surgeon has no alternative but to open the uterus through the peritoneal cavity, and enormously increases the prospect of recovery by removing a uterus found to be infected.

The other ten cases include four in which the child was of disproportionate size, three cases complicated by some local infective condition which prohibited manipulations and delivery through the vagina, and, of the remainder, an example of one of the rarest occurrences in midwifery, a "Missed Labour." A few details will be of interest, as this case has hitherto not been reported.

No. 106. E. F., aged 22, primigravida, passed through uneventful pregnancy to full term when labour began. After a few hours, however, "pains" terminated and the mother ceased to appreciate foetal movements. Two months later her uterus had decreased in size, and, though the foetal contours could be made out, no sign of life could be discerned. Mr. G. Bellingham Smith diagnosed retention of a dead intra-uterine foetus and decided to remove it by Cæsarean section, considering that a uterus which had tolerated the presence of its dead contents for so long was unlikely to react to the usual methods of induction and that this line of treatment would entail a considerable danger of infection. The dead infant was mummified, dried up and shrunken, and the liquor amnii had been almost entirely absorbed, but in other respects it presented the usual appearances of full maturity.

(C) THE AFTER-RESULTS OF THE OPERATIONS

Convalescence.—The column headed "Puerperium" in the Appendix contains a few brief notes on the immediate after-history of each patient. A complete record has not been found practicable, but such information as could be gleaned from a consideration of the temperature chart is noted. Pyrexia has been roughly classified as "slight," "moderate," or "severe,"

and, as is to be expected, fever most commonly occurred after late operations for obstructed labour. For a few days following natural parturition the puerperal woman tends to show variations of temperature from comparatively trivial causes, consequently after Cæsarean section slight pyrexia may be regarded with equanimity. Severe pyrexia, however, usually indicates infection and makes the possibility of a weak uterine cicatrix a point to be remembered in connection with a subsequent pregnancy.

In cases No. 42 and No. 97 intestinal obstruction necessitated laparotomy on the seventh and tenth day respectively after operation. In both freeing of an omental band adherent to the uterine wound was followed by recovery. In case No. 100 constant coughing from bronchitis in a very anæmic patient led to rupture of the abdominal incision and protrusion of omentum on the eighth day; secondary suture resulted in a sound scar.

There appears to be no special liability to pulmonary complications, but when they do arise distress may result from inability to cough efficiently, unless the relaxed abdominal walls be adequately supported by broad transverse bands of strapping reinforced by a fairly tight many-tailed binder. In uncomplicated cases lactation is normally established; it is quite unusual for breast-feeding to be in any way interfered with.

After-history.—In 1920 a "follow-up" investigation was made of all non-fatal conservative Cæsarean sections performed in Guy's Hospital between 1912 and 1918, with especial reference to subsequent pregnancy.

A circular letter was sent to fifty-seven mothers requesting them to attend at the hospital or, alternatively, to reply to a series of questions.

Twelve were untraceable, thirty-six were interviewed and interrogated, and nine answered by post. Information was therefore obtained from forty-five. The results may be summarised as follows—

(A) No subsequent pregnancy	18
(B) Subsequently became pregnant	27
(1) Delivered per vias naturales	6
(2) Repeated Cæsarean section	13
(3) Abortions	3
(4) Then pregnant	6
(5) Rupture of uterine scar	0

Relative sterility amounted to eighteen out of forty-five cases = 40 per cent., but it was found that preventive measures

or other circumstances accounted for this fact. One of the three abortions mentioned had been artificially induced; there is no increased tendency to miscarriage after Cæsarean section. Of the infants, three out of forty-five were stillborn for various reasons, forty-two were discharged with their mothers, and thirty-nine were alive and well at ages ranging from eight to two years at the time of the investigation.

Rupture of the uterine scar in a subsequent pregnancy is the gravest possible after-result of a Cæsarean section. No instance of this accident has been met with at Guy's Hospital since 1899, when Mr. J. H. Targett successfully operated upon a woman who was admitted in labour in a state of collapse with a fœtus lying free in the peritoneal cavity. Laparotomy was performed, the fœtus and after-birth were removed, and hysterectomy was done (*vide* G. H. Museum, Spec. No. 5784). Two years previously she had been delivered by Cæsarean section after many attempts at decapitation of a shoulder presentation had proved unsuccessful. In cases Nos. 3 and 38 hysterectomy was performed on account of "incipient rupture" of a uterus weakened by a previous Cæsarean section.

Mr. Eardley Holland in his recent collective investigation, in connection with which our figures were ascertained, proved that the fear of the Cæsarean scar rupturing during subsequent pregnancy is no imaginary one. He was able to collect ninety-seven recorded instances of rupture, and to show that during the six years included in his inquiry this disaster happened in no less than 17 out of 415 cases of pregnancy and parturition following Cæsarean section, *i. e.* in 4 per cent. He further calculated that "15 ruptures occurred in 301 cases of advanced pregnancy after the use of cat-gut, a proportion of 1 in 20; and that 2 ruptures occurred in 91 cases after the use of silk, a proportion of 1 in 45.5." On this evidence he based a strong plea for the use of silk, or preferably silk-worm gut, for suture of the uterus. This question is referred to in the section dealing with "Technique."

(D) THE RÔLE OF THE OPERATION OF CÆSAREAN SECTION IN OBSTETRICS

Fifteen years ago delivery by means of Cæsarean section was practised but seldom, and only for reasons which were permanent, such as considerable pelvic deformity. More recently obstetricians have found justification for extending the indications for the operation so as to include a great many of the complications of pregnancy and parturition. Moreover, whereas

it was formerly customary to sterilise a woman by salpingectomy at the first or second operation, it is exceptional at the present day for subsequent pregnancies to be prevented or discouraged.

It is an undisputed fact that many babies and a smaller number of mothers have been saved at the greatest crises of their lives by the more frequent performance of Cæsarean section, and that this constitutes an advance in obstetrics. It is also, unhappily, common knowledge that lives are risked and lost unnecessarily by its adoption in unsuitable cases.

The factor which is chiefly responsible for disaster after the operation is infection of the uterine cavity, and the probability of such contamination must usually be assumed when labour has progressed to rupture of the membranes, when vaginal examinations have been made, and particularly after attempts to deliver with forceps. As has already been stated, the mortality of late emergency operations in our series was 18 per cent. This high death-rate should alone be a sufficient deterrent against the performance of an operation unless it be absolutely demanded, but the responsibility of the surgeon does not end with his patient's recovery. A woman who survives a septic operation may have acquired the perilous legacy of an imperfectly united uterine wound.

Sufficient has been said to emphasise the urgent necessity of recognising the gravity of the contra-indication of sepsis, and of realising that a subsequent pregnancy or labour in a woman whose uterus has been incised can never be entirely free from anxiety.

PELVIC CONTRACTION

This condition will always be the most common indication for Cæsarean section. Any considerable degree of deformity should be treated by abdominal section at term, and the induction of premature labour should be reserved for those cases in which it can be postponed until the last four weeks of pregnancy.

Any one who has the opportunity of examining women in the last weeks of pregnancy will agree that a positive assurance can be given in the vast majority of cases that labour at term will be mechanically satisfactory, that in a very small number it will be obvious that natural delivery will be impossible, and that in another small group the issue will be doubtful. It is with the last group that difficulty arises in deciding upon the proper course to pursue. Obstetrics is not an exact science. Pelvimetry serves but to demonstrate the extremes of adequacy or inadequacy in pelvic space, and takes no account of the

proportions of the child or of the strength of the expulsive forces.

By the well-known method of endeavouring to push the foetal head into the pelvic brim after the abdominal walls have been relaxed by anæsthesia a definite decision can be arrived at in many of these doubtful cases. In some labour at full term can be permitted, in some induction of premature labour may be feasible, in others Cæsarean section can be decided upon. There will remain a certain number of cases which must be allowed to start labour on the understanding that Cæsarean section will be available if the head of the foetus fails to enter the pelvic cavity after three or four hours. This line of treatment is only justifiable if the surgeon is competent to observe the progress of labour without making examinations per vaginam; the pelvic cavity can be explored per rectum most satisfactorily after a little practice. In the absence of contra-indications preference should be given to Cæsarean section over the attempted application of the forceps to an unengaged head, a dangerous expedient only to be sanctioned as a forlorn hope.

ECLAMPSIA

The problem of the treatment of the convulsive stage of the acute toxæmia of pregnancy is a subject around which much dispute has centred. Broadly speaking, obstetricians are divided into two camps, those who would rely entirely upon medical lines of treatment, and those who would regard evacuation of the uterus as the prime factor in favouring recovery. As is usual in controversy in medicine, statistics can be produced in support of the teachings of both of the rival schools. It has been shown by Tweedy and by Carlton Oldfield, among others, that eclampsia can be treated by the expectant method with a very low mortality, but there is reason to believe that their results were obtained chiefly in early cases. Freud, on the other hand, was able to report 551 cases from the Berlin Maternity delivered within one hour of the onset of fits with no deaths.

The Guy's Hospital clinical reports for the years 1910 to 1920 include thirty-three cases of eclampsia, of which ten died. This high mortality is explained by the fact that many of the patients were admitted after the disease had progressed unfavourably in the hands of their private practitioners. During the second half of this decade fifteen cases were treated with three deaths; seven were delivered by Cæsarean section (including two operations performed before the foetus was viable and one vaginal Cæsarean section).

It would be unjustifiable to arrive at any definite conclusions as to the relative merits of expectant or surgical methods from the relatively small number of cases in our series. One observation can, however, be made. It was found that when the fœtus was already dead at the time of operation the mother subsequently succumbed. This fact is logically explained on the reasonable assumption that the death of the fœtus in utero is an indication of a severe degree of toxæmia, but it is equally fair to hazard the suggestion that in the very severe cases surgical shock may have been a contributory cause of death.

The writer's personal conviction is that early cases of ante- and intra-partum eclampsia are directly benefited by evacuation of the uterus, and he would advocate that this be done by the speediest method consistent with safety. If it be claimed that equally good results as regards the mother can be obtained by expectant methods, he would point to the greatly increased prospect of a living child if delivery be hastened. Safe delivery can be effected with forceps if labour be sufficiently advanced, otherwise the classical Cæsarean section is the operation of choice; nothing can justify any form of "accouchement forcé." But when the patient is not seen until a grave stage of toxæmia has been established chief reliance should be placed upon non-surgical measures. It need hardly be said that operative procedures must only be considered if everything is surgically favourable for their successful performance, and when any considerable delay will be entailed by the removal of an eclamptic patient to a hospital she is better treated medically in her own home. The secret of success is efficient treatment at the earliest possible moment, and surgical intervention must only be regarded as an adjuvant to medical treatment.

ANTE-PARTUM HÆMORRHAGE

Cæsarean section has a limited, but clearly defined, place in the management of "unavoidable" and "accidental" hæmorrhage.

Placenta prævia may constitute a grave threat to the life of a pregnant woman, but this danger can be averted with the happiest results by means of the older obstetrical methods in the vast majority of cases. Our cases have in the main been treated by one of two methods, by plugging the lower uterine segment with the half-breech or by the use of the hydrostatic bag. It is with pride that one recalls the fact that the former life-saving method was introduced by Dr. Braxton Hicks,

Obstetric Physician to Guy's Hospital from 1859 to 1883. Herman's maxim, "Early version, slow extraction," is in itself a clinical lecture on the management of this emergency of pregnancy. It emphasises the necessity for the immediate control of bleeding and, no less important, for the provision of an interval for recuperation before the completion of delivery. Cæsarean section imposes an inevitable additional loss when it can least well be withstood. That there are cases, however, for which Cæsarean section is pre-eminently the best treatment will not be denied. When very profuse bleeding occurs and the cervix remains undilated and rigid, prompt delivery by abdominal section offers the best hope of saving the mother. Again, when the patient's condition is satisfactory, the foetus alive and of sufficient maturity, and when delivery as a footling is likely to result in stillbirth, a good case can be made out for Cæsarean section in the child's interests. But not many cases will fulfil these conditions; the mother is but rarely a *primigravida*, and the onset of hæmorrhage is not frequently delayed until the last weeks of pregnancy.

The treatment of accidental hæmorrhage by vaginal tamponage or by artificial rupture of the membranes is almost always satisfactory; efficient contraction of the uterus results, with consequent cessation of bleeding and expulsion of the gestation. There are, however, well-recognised cases of toxæmia of pregnancy in which degeneration of vessels at the placental site and of the uterine musculature combines to produce a perilous degree of concealed hæmorrhage with a paralysed atonic uterus. The only sound procedure in these desperate, but fortunately rare, cases is Cæsarean section, which must be followed by hysterectomy if the uterus fails to retract after it has been emptied of its contents.

PELVIC TUMOURS

On a previous page some details were given of eleven cases operated upon because tumours in the pelvis complicated labour, or, having been discovered during pregnancy, were thought likely to cause obstruction. It is a surprising fact that only about one case a year demanded Cæsarean section when it is remembered how common it is for certain neoplasms to arise in the pelvic organs of women during the child-bearing period.

The occurrence of pregnancy in a uterus, the seat of fibromyomata, may sometimes be attended with dire results, but it would be a mistake to suppose that degenerative changes in

the tumour, abortion, obstruction to delivery, or puerperal infection are an inevitable outcome of the association. Only in a minority of cases do any complications arise; many have been under observation in the Obstetrical Department throughout uneventful pregnancy to normal confinement and puerperium. Doubtless fibroids frequently exist without their presence being suspected.

If a myoma of any size is situated in the cervix, or in the anterior part of the lower uterine segment, difficulty is to be anticipated, but if it lies in the posterior part of the body of the uterus there is a good prospect of it being drawn up out of the pelvic cavity during labour.

When the position of a fibroid threatens the easy passage of the child a timely Cæsarean section at full term enables safe delivery to be effected and the tumour to be dealt with at the same time.

Of ovarian tumours the dermoid cyst is that most commonly responsible for obstructing labour, because its size usually permits it to occupy the pouch of Douglas and the relatively solid nature of its contents prevents it from altering its situation in response to the pressure upon it of the presenting part of the fœtus.

It has been the subject of debate among obstetricians as to what is the most advantageous course to pursue when a tumour of the ovary is so placed that it must interfere with delivery. It is stoutly maintained by some that, in the absence of urgent symptoms, operation should be postponed until full term, when by laparotomy the tumour can be lifted out of the pelvis and removed, the pregnancy being left to terminate naturally. There are, however, several objections to this procedure. It will be found, in most instances, that the neoplasm cannot be reached until the uterus has been emptied, and apart from this consideration it seems neither humane nor wise to make a patient go through a natural delivery immediately after an abdominal section.

Among the rarer indications for Cæsarean section may be mentioned certain forms of heart disease with deficient compensation. No instance of operation for this grave complication of pregnancy is recorded in the present series, but mention may be made of a case recently in Victoria Ward.

A woman aged 23 was found on examination at the Ante-Natal Clinic to be suffering from dyspnoea and extreme cardiac arrhythmia at the twenty-second week of her first pregnancy. She was admitted into Esther Ward under Dr. H. S. French, in whose care she remained for the next four months. Investiga-



tion enabled the diagnosis of mitral stenosis and regurgitation with auricular fibrillation to be made. Although rest and full doses of digitalis led to considerable improvement the striking disparity between the rate of pulsations felt at the heart's apex and in the peripheral arteries remained unaltered. Dyspnœa and cyanosis on exertion were still prominent symptoms, and the prospect of her approaching confinement was viewed with anxiety. Dr. French and Mr. Bellingham Smith, in consultation, agreed that Cæsarean section was less likely to be fatal than a possibly protracted labour. Other points in favour of this course were that a living child could be guaranteed and that opportunity would be afforded of preventing another pregnancy by excision of the uterine tubes.

Cæsarean section with sterilisation was accordingly done at approximately full term by Mr. Bellingham Smith under ether anaesthesia administered by Mr. A. D. Marston. The patient made a good recovery and was able to nurse her baby.

Women with damaged hearts of this nature are notoriously prone to fatal collapse after spontaneous labour. One is encouraged to hope that further experience may establish Cæsarean section as a safer means of delivery in some of these cases.

(E) THE TECHNIQUE OF THE OPERATION

No attempt will be made to describe in detail the various steps of an operation with which every reader must have at least some familiarity. For a full description reference may be made to the article on Cæsarean section, written by Mr. Bellingham Smith, in Rowlands and Turner's *Operations of Surgery*, the sixth edition of Jacobson's work. It may, however, be profitable to touch upon a few practical points.

Innumerable modifications of the classical operation of Cæsarean section have been devised and practised in the hope of rendering the uterine scar more secure. The fundus and the lower segment of the uterus have, at different times, had their advocates as the best site for the incision of the uterus, and recently a "muscle-splitting" operation has been recommended. Neither from theoretical nor practical considerations can any real advantage be established for these alternatives to a simple vertical median incision of the upper segment of the uterus. Any delay in the first stages of the operation is to be deprecated, however desirable it may be for the suturing of the uterus to be done with deliberate care; the safety of the child depends upon its being delivered as quickly as possible and handed over to the appointed assistant.

As has already been mentioned, evidence has been produced

that rupture of the Cæsarean scar has more frequently followed the use of cat-gut than of unabsorbable material for the suture of the uterus. The practice at Guy's Hospital has been to make use of No. 3 twenty-day chromic cat-gut in two layers, and particular importance is attached to the careful insertion of the continuous sero-muscular suture so that all the knots of the deep interrupted stitches are buried. No rupture of the uterine cicatrix has occurred in the last twenty-two years, and it is not proposed, for the present, to make any alteration in this detail of technique. It is felt that the high incidence of rupture recorded is due rather to an injudicious selection of cases for operation. If late infected cases are submitted to operation Cæsarean hysterectomy should be performed in order to reduce the immediate danger of death from septic complications and to obviate a possible tragedy from yielding of the uterine cicatrix. Considering the special conditions which obtain in the puerperal uterus, contraction and relaxation with rapid shrinking from intense autolysis, it is only by primary union that a sound scar can be attained. Healing by secondary intention must inevitably result in a weak wound whatever the suture material.

Nor can any real merit be claimed for extra-peritoneal abdominal or vaginal operations. The adoption of these methods is urged by some on the grounds that septic cases can by means of them be more safely delivered. They are much more difficult operations entailing greater delay and more risk of hæmorrhage not easy to control. Moreover, the fundamental assumption that suppuration in the extra-peritoneal cellular tissues is less serious than intra-peritoneal infection cannot be upheld.

When the surgeon is forced to undertake Cæsarean section in a possibly infected case late in labour the usual routine technique should be somewhat modified. As a preliminary the vaginal walls and the presenting membranes should be wiped dry and thoroughly swabbed with picric acid in alcohol; the abdominal incision should be made sufficiently long to enable the gravid uterus to be everted so that the rest of the abdominal contents may be packed off. After the delivery of the child the after-birth should be peeled off with special care so that no fragments are left adherent, and the interior of the uterus should be freely irrigated with hot lotion. It is well to remember that if labour has been in progress some time the urinary bladder may have been drawn up into the abdomen and will be in danger of being cut, and that if much morphia has been given the uterus may be atonic. Unless the uterus is contracting or reacts to the injection of pituitrin delivery

may be followed by such severe bleeding that hysterectomy will be required.

If the uterus is definitely infected, as indicated by offensively smelling liquor amnii, Cæsarean section should only be undertaken if absolutely necessary, and total hysterectomy should be done. Even if a living child is delivered in such a case, it is very likely to succumb to early pulmonary complications.



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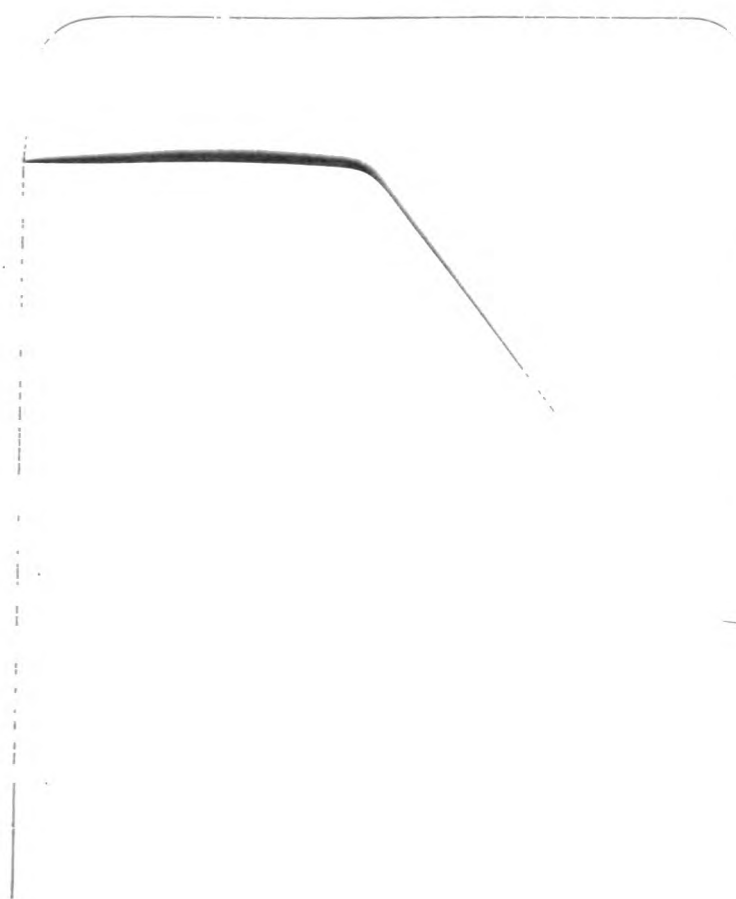
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